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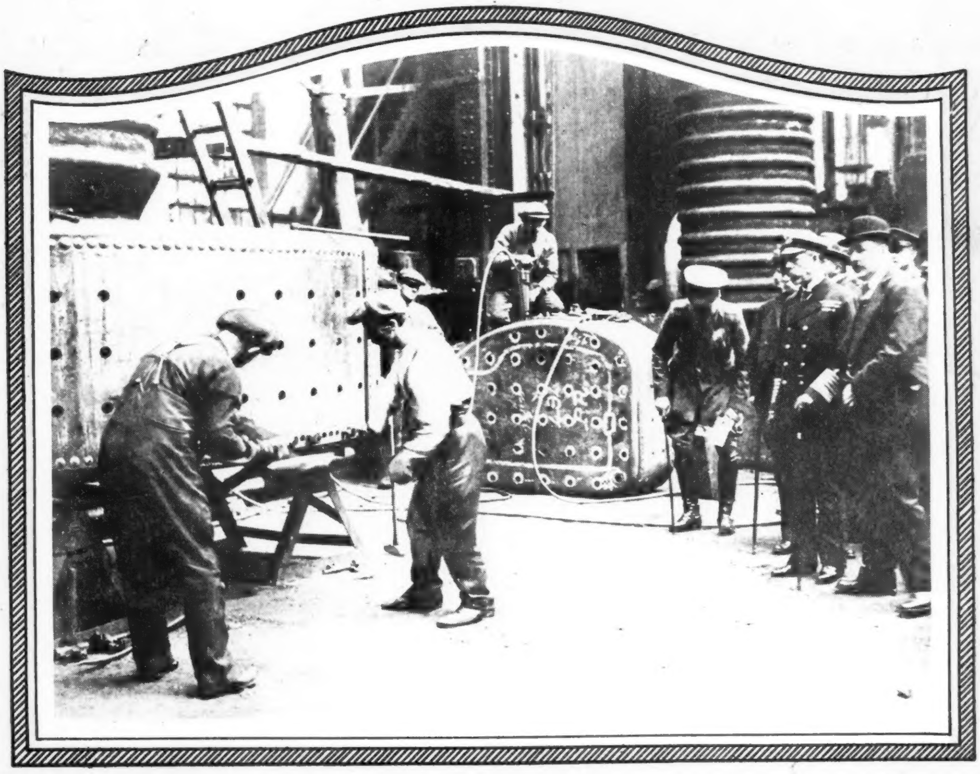

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BRITISH ROYALTY WATCHES PNEUMATIC RIVETING—KING GEORGE, IN VISITING THE CLYDE, TOOK GREAT INTEREST IN THIS USE OF COMPRESSED AIR.

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The Superpower Zone An Economic Necessity

The Future of America's Great Finishing Shop Depends Upon Getting More Energy Out of Every Pound of Coal—Surplus Current to Operate Central Compressed Air Plants

By ROBERT G. SKERRETT

INDUSTRIALLY a nation is no stronger than the measure of motive force that it can furnish continually to its manifold productive activities—be this compressed air, gas, steam, or electricity. It has been said that we could not accomplish the tremendous amount of work done annually in the United States if we had not in mechanical power the equivalent of the sustained efforts of 3,000,000,000 toilers. And yet we know that our vast output of commodities and the transportation of these goods are achieved by an army of workers numbering only a few million.

Heretofore, the producer in America has enjoyed a distinctive advantage over his foreign competitor by reason of an abundance of energy pulsing through the air mains, the gas lines, the steam pipes, or along the distributing wires of the country's electric systems. Only so lately as four years ago, a commission of British experts reported to Parliament that the United States was markedly superior industrially because the American workmen had behind them 50 per cent. more power than their British fellows. As a matter of fact, the difference in our favor was much more. Therefore, that body of investigators urged that England make a move to effect the rapid development of more motive power while using for the purpose a minimum of fuel.

Paradoxical as it may seem, America, too, is face to face with a situation demanding the generation of more energy, and engineers are expected to bring this about at considerably less cost per unit than heretofore. To-day, in order to maintain the American worker's lead in the matter of mechanical aid, and to guarantee wages and profits that will make big enterprises worth while, it is inevitable that there be profound changes in some of the practices to which the country has persistently clung for decades. It will no longer be prudent to burn coal, oil, and natural gas in the spendthrift manner which has been deemed a right because of a wealth of native resources. From now on each B. T. U. must be used as efficiently as possible, not only for the sake of this generation, but in order not to rob the next and succeeding generations. This can be done without present sacrifice and will permit us, besides, to speed up the wheels of industry much beyond their usual pace.

COMPRESSED AIR in its varied and important applications is produced primarily by another source of power; and wider fields of usefulness will inevitably open to this adaptable medium of motive force if more and cheaper primary power be made available. Therefore, together with every other user of mechanical energy, the man that relies upon compressed air should be interested in the proposed Superpower Zone, for through its establishment it will be possible to obtain the initial unit of energy under more highly efficient conditions and, besides, at a lower price.

The Superpower Zone project, so heartily endorsed by the leading engineering societies and the Federal Government, will make it feasible to speed up production, to hasten transportation of freight, and, at the same time, reduce the consumption of coal by 30,000,000 tons annually.

At one crucial period of the World War, America was hard put to it to find motive power anywhere near equal to the multiplying demands. Scores of so-called non-essential industries were closed by the Government so that fuel or energy could be diverted to other and for the once, paramount services. Had the titanic struggle in Europe lasted a year longer, and had America been called upon to give still greater material aid, the public no doubt would have suffered divers privations in the way of chilly habitations and a lack of accustomed comforts and conveniences.

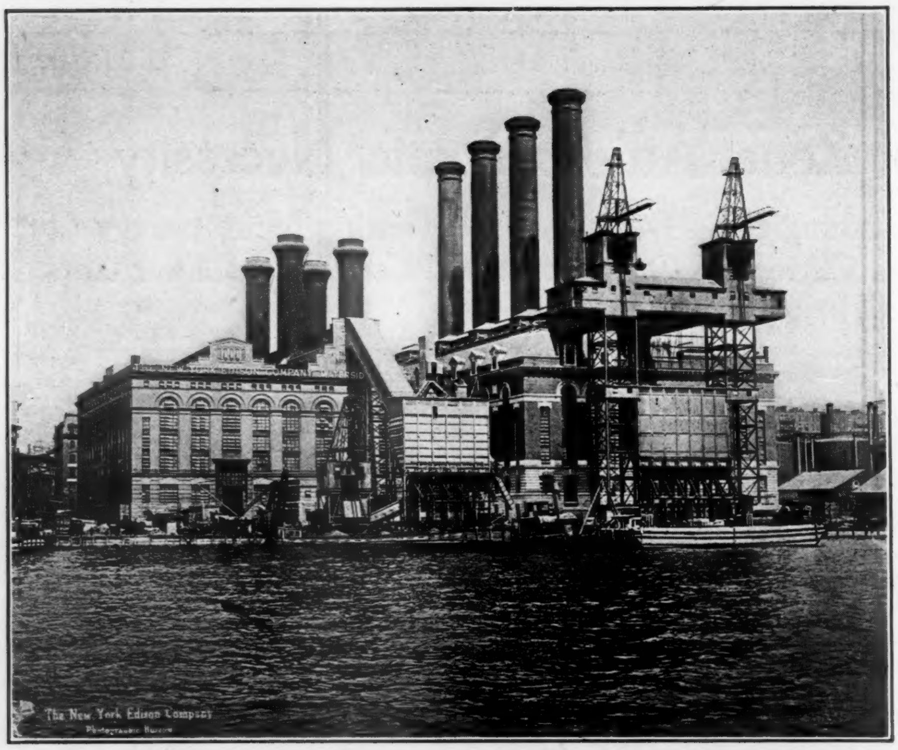
The collapse of the Central Powers saved America this distress, but the imminence of hardship aroused the technicists—especially those familiar with fuel and power crises—to urge that the nation set about putting its house in order by making itself better able to deal with the problems of peace. In short, unify engineering experience for the benefit of the nation and develop measures and methods by which it would be practicable to stimulate production and to promote the more rapid distribution of foodstuffs, the output of mines, factories and mills.

With this thought in mind, one far-seeing electrical expert, William Spencer Murray, inspired a year ago, a notable symposium at the mid-winter convention of the American Institute of Electrical Engineers; and the outcome of that agitation was the approval of engineering counsel, represented by the four great founder societies—the American Institutes of Mechanical, Electrical, Mining, and Civil Engineers. The broad purpose of the scheme proposed and thus advocated was to bring into being a vast inter-connected system of power transmission covering a region reaching north from the District of Columbia to the southern parts of Vermont and New Hampshire and extending inland from the seacoast for distances ranging from 100 to 150 miles. Appreciating the national character of the project, Congress appropriated $125,000 to help cover the work of preliminary investigation, and other material support has been supplied by private enterprise desirous of promoting the common weal. The investigation, known as the Superpower Survey, is proceeding under the auspices of the United States Geological Survey, with Mr. Murray immediately in charge.

The object of the proposed Superpower Zone, as the area in question is called, is to lead to an annual saving in the near future of 30,000,000 tons of coal and to effect yearly economies within this region of substantially $300,000,000. But even beyond this, the scheme promises so to improve rail transportation that

some of the great trunk lines will be able to handle more expeditiously a far greater tonnage of freight and thus provide an easier flow of commodities from their primary sources to the ultimate consumer. Offhand, familiar as we are with the overburdened state of our railways and the cluttered condition of freight yards and terminals, the realization of the amazing changes prophesied by the proponents of the superpower zone project seem well-nigh unbelievable. But before this article is concluded we shall see that the technicists engaged in making the survey, and those forming the no-less responsible Advisory Board, are not guessing, but are marshaling an array of facts and figures that any layman should be able to grasp without difficulty.

How many that use electricity in the home and appreciate its advantages, stop to think what we should have to spend for that adaptable energy if each of us had to operate a generator in the cellar? Some of us might manage this within reasonable cost limits, but the vast majority of us would have to pay dearly for that domestic convenience. Instead, what do we do? We get our current from a central power station and thus rid ourselves of personal responsibility, a deal of labor, and no end of expense. And yet, on a larger scale, thousands of industrial establishments are developing their own power—a few efficiently, but many of them in a thoroughly wasteful fashion, judged by truly modern standards of fuel utilization.



A great central station that typifies in operation the efficiencies and economies that would apply to a much larger field through the creation of other and even bigger superpower zone plants.

Photos Courtesy N. Y. Edison Company.

The up-to-date central station develops a kilowatt hour on a consumption of a little more than two pounds of coal, while the smaller isolated plants burn on an average quite eight pounds of coal in generating a like unit of energy.

The factories and plants that are run economically, so far as the charge for primary motive power is concerned, are those that purchase their operative current from up-to-date central stations. But even in these stations there is room generally for much improvement either in equipment and management or in the fuller and more profitable employment of the apparatus installed. The load factor could, no doubt, be raised to advantage by using the current elsewhere to drive batteries of air compressors, thus storing up conveniently and cheaply energy for many purposes at points where there is a demand for this motive medium.

Realizing the need of betterment, the trend in some parts of the country is toward linking together, "hooking up" as it is popularly put, a series of otherwise unrelated electric power stations, so that one can help the other in meeting a peak load, in supplying a deficiency caused by a break-down or a sudden demand, and in making in practicable for each and all of these plants to operate more nearly continuously at maximum capacity. In other words, the arrangement enables them to pool their output, to find a market for surplus energy, and to satisfy the diversified requirements of a correspondingly wider field. In this way, central stations that are only neighbors at the start become relatives through bonds of service that benefit them and the community as well.

But the sporadic promotion of this relationship is not in itself sufficient to solve the present problem and to give to the zone in question promptly the power now needed as well as to provide for that still bigger block of energy which will surely be called for in the near future. The manufacturer, the mill owner, the machine shop proprietor, etc., all go right on building or extending their establishments, giving little heed the while to what their activities may impose first upon the nearby community and then upon the State at large. Each of these captains of industry expects to get either his fuel or energizing current whenever he needs it and, what is more, to obtain it in a measure agreeably to the changing demands of the hour.

Investigation discloses the amazing fact that our power requirements are doubling substantially every five years; and that being the case how can we hope to move in season enough coal from our mines to the consumers **to fill their continually multiplying and ampli-**

fying bins? Within the area embraced by the contemplated superpower zone is burned approximately a third of all the coal consumed by the country at large. For power purposes alone this means an expenditure of fully 74,000,000 tons every twelvemonth; and the aim is to reduce this 50 per cent. and to lessen proportionately the transportational task of the railways. To achieve this it will be necessary to electrify 6,000 miles or one-fifth of the mileage of the trunk line railroads within the boundaries of the superpower zone where the density of traffic warrants the abandonment of steam traction. At the present time, those particular roads burn 75 per cent. of the coal used by the railways within the area in question.

While the advocates of the steam locomotive not unreasonably argue that their type of tractor is still undergoing improvement, which is true, yet the steam engine is an example of the isolated plant, likely to give widely varying results in different hands, and always inferior in performance when compared with a big central station generating energizing current for electric traction. Weather and atmospheric conditions that gravely hamper the raising of steam and its maintenance at a suitable pressure in a steam locomotive have relatively little influence upon the showing of a large stationary power plant. Experience on one of the older of our electrified trunk lines proves that a steam switching engine calls for the expenditure of four times as much coal as that consumed in furnishing current for an electric locomotive engaged in the same service; that the firing of the steam freight engine requires two and a half times the coal burned to energize an electric freight tractor; and that an electric passenger locomotive does its work on a fuel outlay just half that of its steam competitor. Further, since these data were obtained, the thermal efficiency of central stations has been increased anywhere from 100 to 150 per cent.

It is not the purpose of this article to delve into the technical niceties of the electric locomotive and to expatiate at length upon its distinctive merits other than to say that the newer engine has a firmer grip upon the rails, and by reason of this it can handle longer or heavier trains than the "steam horse." Accordingly, each electric locomotive, for a given number of train-miles, will shift from point to point a larger volume of freight and do this faster—incidentally earning higher returns while effecting substantial savings in operation. Finally, the electric locomotive will maintain schedules and go steadily on under weather conditions that would seriously hamper, if not halt, the steam tractor. What we need is increased capacity on our trunk lines—i. e., ability to haul more and to handle it quicker than heretofore; and, happily, the electric system can achieve this in combination with the economies recited.

The superpower zone plan, in principle, embodies the highest development of the central station idea in conjunction with a far wider application of the interlinking of power plants of public utilities. That is to say, the scheme will carry further and to the present logical

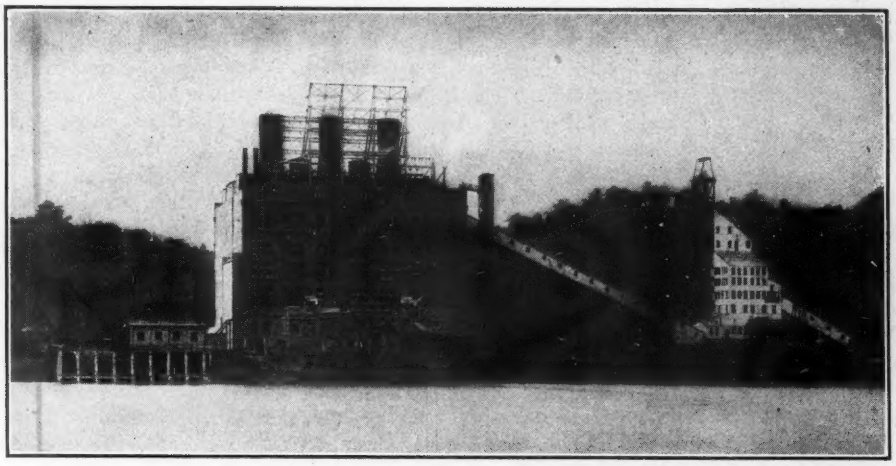


Photo Courtesy West Penn Power Company.

A 250,000 kilowatt power plant located in Pennsylvania right at the mine mouth and within convenient reach of an abundance of condensing water. It is thus possible to distribute energy in the form of electric current instead of coal throughout a wide district.

Photo Courtesy Westinghouse Electric & Mnfg. Co.

The electric locomotive for switching service calls for the burning of only one-fourth as much coal as that needed to maintain a steam engine in yard work.

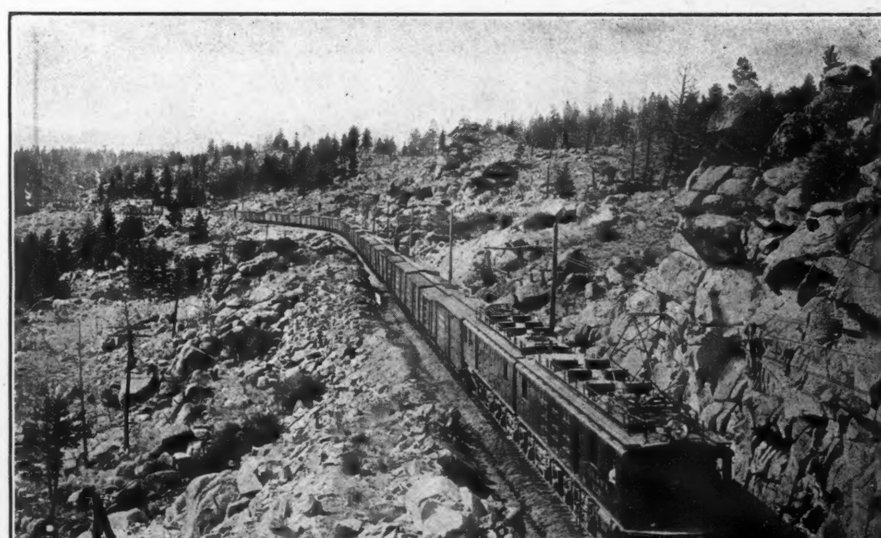


Photo Courtesy Chicago, Milwaukee & St. Paul Ry.

A heavy freight train negotiating a two per cent. mountain grade by electric traction. The electric locomotive can thus deal more effectually with conditions that bottle neck traffic when the main reliance is the steam engine.

climax practices that have been found advantageous within more restricted areas. The mere term superpower has led many to believe, and erroneously, that the proposed undertaking would embody much hitherto untried in the realm of generating and distributing a great tide of electrical energy; that it would necessitate costly engineering projects of debatable effectiveness; and force changes upon the owners of existing plants and steam railways that would cause the scrapping of millions and millions of dollars worth of property now in daily service. This misconception must be dispelled; there are facts at hand to help to this end.

To begin with, let us see what are some of the outstanding characteristics of the region encompassed by the boundaries of the proposed superpower zone. The land area of the States concerned is only two per cent. of the entire area of the United States and yet there are packed within this territory 22 per cent. of the country's population. To meet the needs of these people and their diversified activities approximately 35 per cent of the total horsepower of the whole nation is developed there; and with this volume of mechanical force at their disposal these citizens produce about 40 per cent. of all of our manufactured commodities. It is therefore not hard to visualize the intensified industry within this teeming section; and to appreciate the fact that there must be a steady flow of raw stuffs inward and a similar movement of finished articles outward lest grave social and economic disturbances arise.

At the present time there exists a demand for 20,000,000 indicated horse-power on the part of this zone, and of this, 12,500,000 is in the service of the different industries and 7,500,000 constitutes the propelling force that operates the railroads. Contradictory as it may seem, even though industrial users are hard put to it for power as the resources exist to-day, the aim is actually to curtail the steam plants now running and to get more economically the block of power required for current needs by operating fewer stations at the full rated capacity of their equipment. There is nothing unusual in this; and a single example will suffice to illustrate the principle involved.

A few years back, down in Logan County, West Virginia, there were numerous scattered mining properties, each of which operated its own steam plant—the aggregate of all the boilers being 40,000 horse-power. Subsequently a central station was built to supply these several enterprises with electric current, and it was found that a development of only 5,000 kilowatts would answer every purpose where previously coal was burned to produce nearly eight times as much power! At one stroke, the labor force, the fuel consumption, and the overhead charges were reduced in a marked degree.

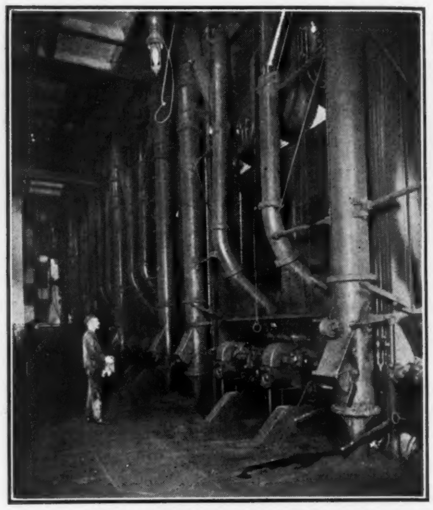
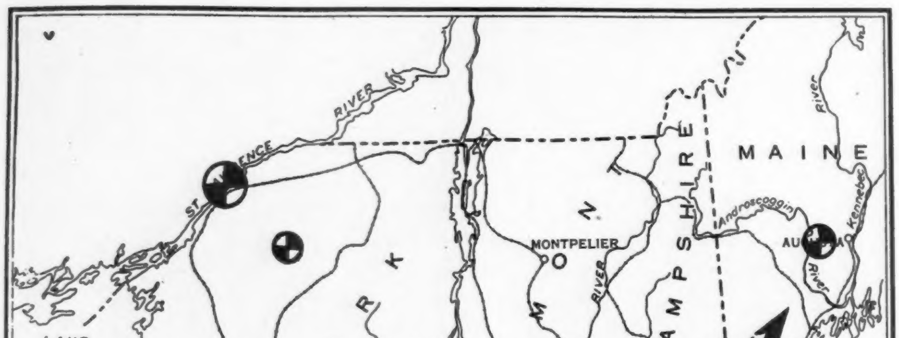


Photo Courtesy N. Y. Edison Company.

The mechanical stoker makes it practicable to burn coal far more efficiently than when the fuel is hand fired and it incidentally greatly reduces the number of men needed in the fireroom.



Illustrating the generating centers and the radii of contributing circuits leading from sources of power outside the boundary of the superpower zone.

When the survey for the superpower zone was started in August of the year gone, Mr. Murray based his preliminary figures of coal burned per unit of power upon a general average that he realized was only an approximation; and one of the objects of the survey was to arrive at more nearly exact data so that he and his technical associates could point authoritatively to the channels through which much desired savings could be effected and efficiency broadly increased. After months of painstaking investigation, in which manufacturers, railroads, and public service agencies have coöperated heartily, the coördinated material yields some impressive information.

It is thus revealed that the electric utilities, taking them by and large, are using a little less than three pounds of coal per kilowatt hour, while isolated manufacturing plants, as a rule, are burning about eight pounds to generate a like unit of energy. And it seems that the steam railroads, for an equivalent of a kilowatt hour, consume on an average substantially seven and a half pounds. Against this showing, there are in active operation large and capably administered central power stations that are developing a kilowatt hour on an expenditure of but two and three-tenths pounds of coal. With the completion of certain improvements in hand or contemplated, it will be possible for these establishments to obtain a kilowatt hour for one and seventenths pounds of fuel.

This added efficiency will proportionately lessen the cost of primary energy for the op-

William Spencer Murray, the originator of the superpower zone project.

eration of air compressor units and increase the use of electrically-driven machines.

A year ago, when Mr. Murray read his epoch-making paper, *Economical Supply of Electric Power for the Industries and the Railroads of the Northeast Atlantic Seaboard,* he assumed that the creation of a superpower zone would result in a saving of not less than 30,000,000 tons of coal per annum. The information now in the possession of the survey indicates that that figure was not an overstatement of the fact, based upon the coal fired and the power generated during 1920. Not only that, but it is evident to the experts studying the subject that if we hesitate about calling the superpower zone into being, the sum of our extravagance in 1930 will have reached the annual total of 53,000,000 tons of coal burned needlessly. It should be well to recall that the North Atlantic seaboard now uses for all purposes 150,000,000 tons of fuel each twelvemonth; and most folks are pretty familiar with the difficulties encountered in effecting the distribution of that coal.

The transportation of this essential raw stuff from the mines represents 40 per cent. of the total tonnage handled by the railways. Manifestly, the elimination of 30,000,000 tons would reduce this movement by twenty per cent and leave the tracks freer for the carriage of other freight. There are 9,000 locomotives now operating within the superpower zone limits; and somewhere between twelve and fifteen per cent. of the tonnage hauled by these tractors brings in no revenue, consisting as it does of tenders and their charges of coal together with the fuel required for other phases of railway activities.

When the electrification of the New York, New Haven & Hardford Railroad was taken in hand, each electric locomotive was expected to operate on a basis equivalent to that of the steam engine, i. e., pull 1,200 tons. In the relatively brief period that has intervened the trailing load of the electric locomotive on that line has grown to 4,000 tons. Fewer tractors, then, are able to deal with the traffic. As has been cited repeatedly in some of the technical journals, the Chicago, Milwaukee & St. Paul Railroad has found it practicable to supplant 112 steam engines by 42 electric locomotives, and the new machines are not only taking care of a greater tonnage than hitherto but have sufficient capacity in reserve to move a still larger volume of freight. A certain road in a West Virginia coal district, where the grades are extremely heavy, installed twelve electric locomotives in place of 33 great steam freight engines; and as a consequence of the change the line is drawing trains of 3,500 tons at a speed 100 per cent. higher than previously.

It has been estimated that the coal required for power in 1919 within the area of the proposed superpower region amounted to 74,000,000 tons. Four years hence, if the superpower zone were in operation, and taking industrial expansion into account, the coal needed for power service would reach 75,800,000 tons; and by 1930 the annual consumption for this purpose would equal 84,800,000 tons—showing an increase of fourteen per cent. in coal consumption despite the economies which the superpower system would make possible. These figures are presented to answer the query, "What is to be done with the present coal cars if some of the big railways be electrified extensively and many industries obtain their energy from central stations instead of burning fuel wastefully in their own plants?" We still shall have to haul from the mines to the

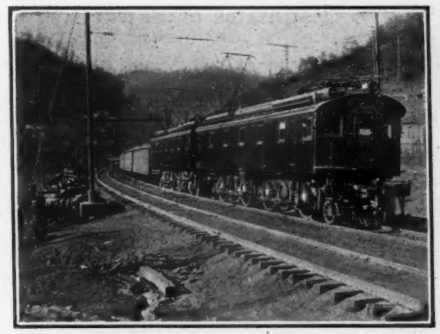
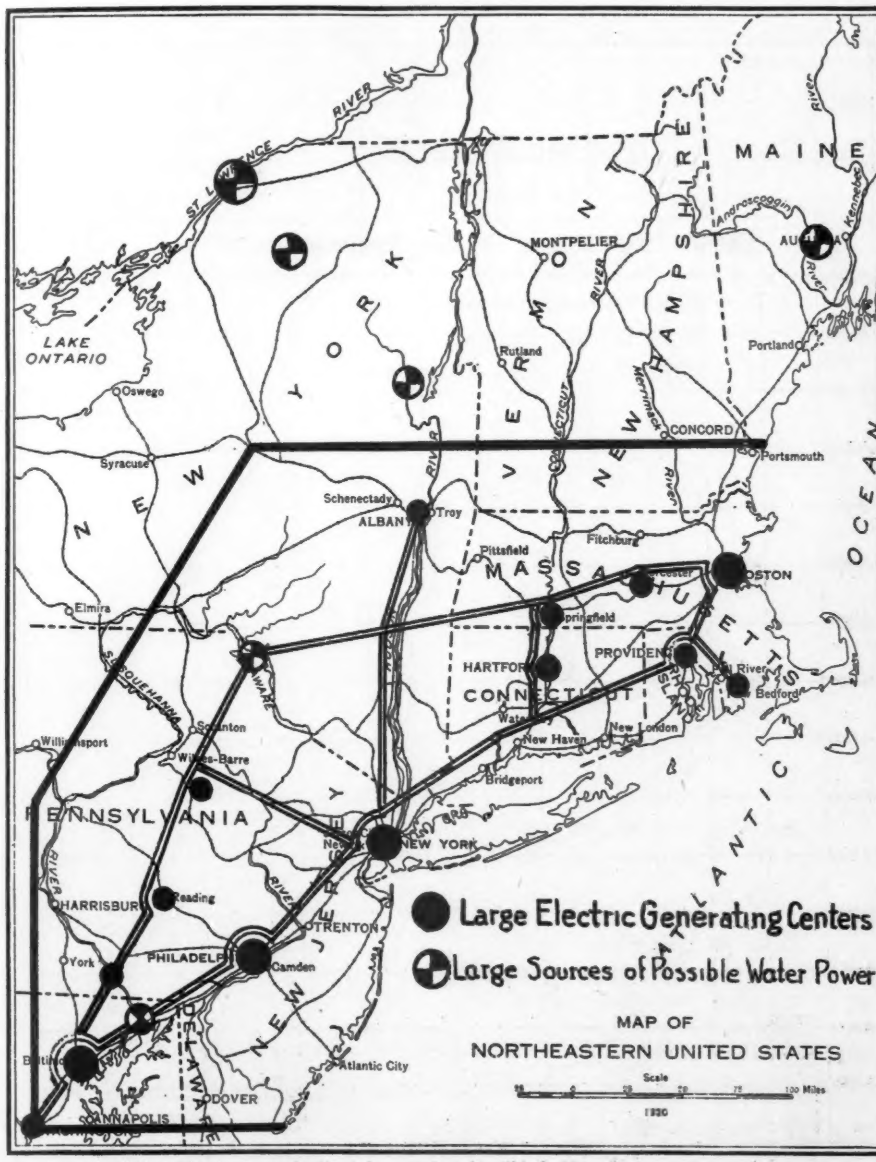


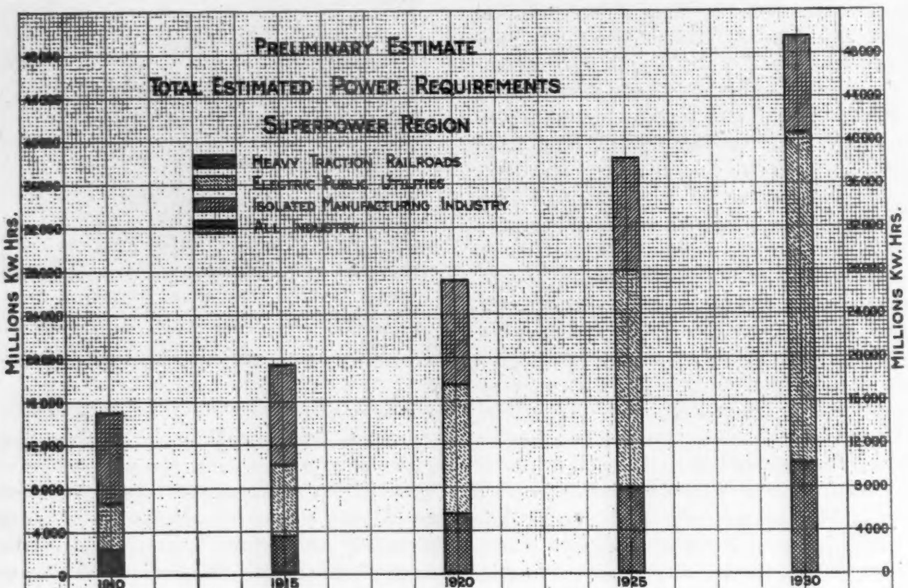
Photo Courtesy Norfolk & Western Railroad.

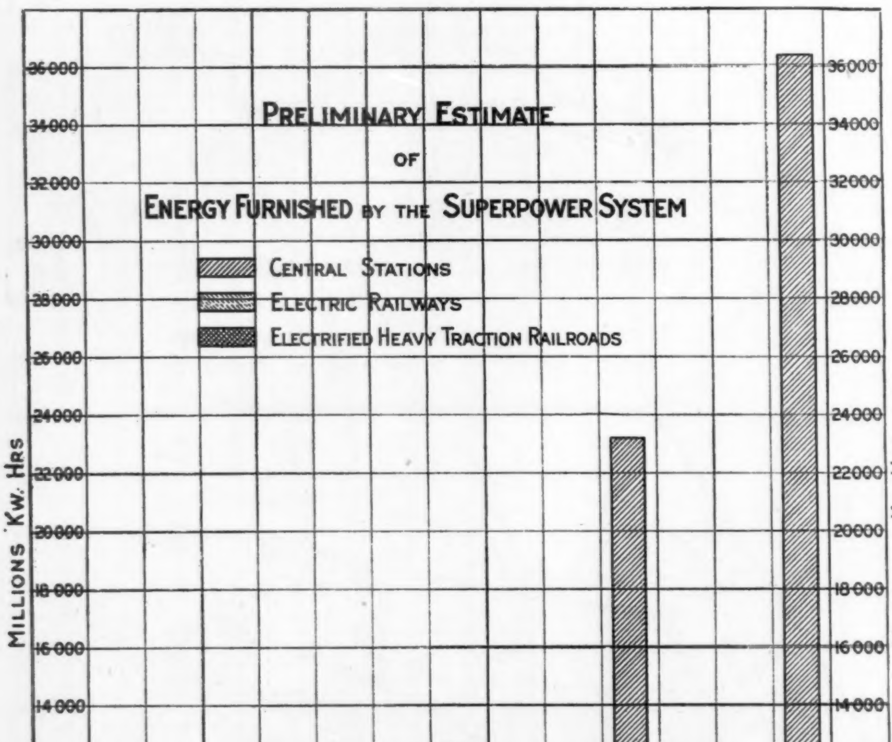
A 3500-ton coal train mounting a slope at a speed 100 per cent. higher than previously possible when the line used steam locomotives.



Showing in a general way the positions of possible superpower central stations and the manner in which they might be linked in the trunk-line circuit.

Estimates of Power Requirements for Superpower System.





new super central stations a tremendous quantity of coal, and these vehicles will be needed for that work. As for the steam locomotives that will be released when any of the lines are electrified, these engines will be absorbed by the other roads within the zone that will still rely upon steam traction. Indeed, these railway systems will probably have much more to do when the superpower zone comes into being, and they will therefore require these additional facilities.

We are purposely dwelling upon this topic of coal, first, to stress the necessity of conservation and, next, to make equally clear what will be the gains through a more efficient utilization of the fuel. While the superpower zone will embrace the building of big hydro-electric stations, and the plan is to make the most of water-power wherever feasible, we cannot dodge the fact that our chief reliance as a source of energy will be the coal fields contiguous to the superpower region. It is also well to keep in mind that the industries using coal to-day insist upon the best grades, and these are dwindling.

Assuming the total developed horse-power—hydro and steam—in the superpower zone to be 19,372,000 at the present time, there still remain undeveloped water-power sites which may yield 3,800,000 horse-power—i. e., an increase of 19.5 per cent., which would bring the total, in the absence of further steam plant expansion, up to 23,172,000 horse-power. As matters stand now, the total energy requirements of the district amount to substantially 20,000,000 horse-power for all purposes. By 1925 this will have reached 22,600,000 horse-power, and five years thereafter it will be necessary to meet an energy demand calling for 24,800,000 horse-power. Inevitably this will entail the consumption of much larger quantities of fuel.

It probably has not occurred to most of the people living in the North Atlantic States that the coal fields of Pennsylvania represent only a moderate part of the nation's fuel supply and, further, that but sixteen per cent. of all our coal resources are within easy hauling distance of the eastern seaboard. And yet, in the face of this fact, so pregnant with food for thought, the greater quantity of the coal mined in this country is taken from the convenient Keystone State, which holds but one-sixth of our available store. If we are to continue to depend in the main upon these nearby deposits, thus minimizing as far as practicable railroad mileage, it is imperative that we make each pound do its maximum work and devise ways, besides, that will permit us to distribute energy in the form of electric current rather than potential energy in the shape of millions of tons of coal. As Mr. Murray has well expressed it: "Power in the form of coal is maximum in bulk and minimum in efficiency, whereas if it is in the form of electricity the exact reverse occurs, namely, it is minimum in bulk and maximum in efficiency."

One phase of the problem, then, is to create a series of high-economy steam electric plants at or close to the mine mouths and, likewise, at tide water. These would be large enough to carry the major part of the great energy

base load of the superpower zone. The position of a plant at or near a mine will depend upon the availability of a plenty of condensing water. By tying these big generating stations together by means of high-tension transmission lines, making them feed into a common distributing system, it will be feasible to bring down the coal consumption per unit of all power thus developed to less than two pounds per kilowatt hour. Each of these power sources would have steam turbo-generators capable of furnishing continuously a total of 300,000 kilowatts.

The savings that may be assured through the adoption of such a scheme are by no means restricted to coal conservation. There would be a direct reduction in monetary outlay due to the practicability of providing joint reserve equipment instead of having, as now, at each station or plant, idle apparatus as a safeguard against breakdown. This communal arrangement would hold to a minimum the installation of intermittently productive machinery. The stations would normally pour their streams of current into one vast and far-flung pool or reservoir of electrical energy; and should a generator fail at any plant instantly a reserve machine would be swung into action to make up the loss and to keep the general "level" of the system at the point desired.

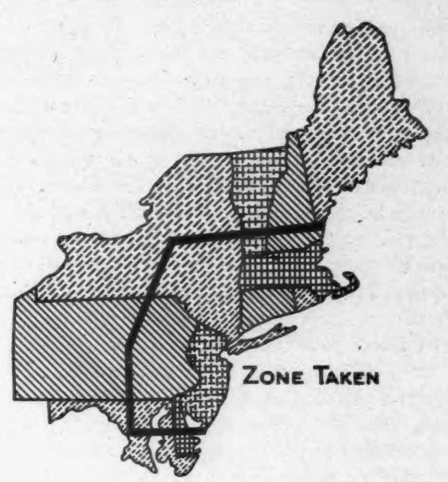
This assurance of an unfailing and an abundant supply of current should go far towards encouraging the installing of electrically-driven air compressors where it may not be convenient or advantageous to use oil or steam-driven equipments.

The question has been asked, "What is to be done with extant power plants: are they automatically to cease to serve?" The object of the superpower zone is not to force the abandonment of existing stations, especially if their economy of operation is equal to or near that of the contemplated master plants. Highly efficient stations will have a chance to run at capacity for 24 hours a day and will be encouraged to contribute any of their energy in excess of local needs to the wires of the zone system for utilization wherever wanted. On the other hand, power plants unequal to neighboring requirements or sudden demands will draw current from the superpower lines and pass it on to their consumers—possibly obtaining this block of energy on an expenditure of coal considerably below that of a similar volume turned out by their own equipments. Logically, no power user is going to operate an independent steam installation if he can purchase all the power he desires for much less money and avoid, the while, outlays and annoyances inherent to the running of an isolated outfit.

It follows, of course, that to make the most of our undeveloped water power within the region concerned we shall have to build large hydro-electric plants and to establish these on the principal rivers. However, it may be found advisable to locate some hydro-electric stations outside the zone but within transmission distance of it. As two of our illustrations show, we may go to the St. Lawrence River or well into the State of Maine for this purpose, if circumstances warrant. To-day, high potential current is being transmitted for 100, 200 and 300 miles; and it is suggested that the current delivered to the wires for distribution shall be of 250,000 volts—i. e., of from 275,000 to 280,000 volts at the generators. It is authoritatively stated that it would be possible on a three-wire circuit to transmit 400,000 kilowatts for 150 miles with an energy loss of only about five per cent. And there are manufacturers of electrical equipment that stand ready to guarantee suitable insulators to protect the tremendous voltage proposed. Indeed, from the very nature of the transmitting trunk line for alternating current, certain self-balancing effects would be obtained that would tend to minimize derangements at any point. That is to say, in case of a breakdown at a Philadelphia station, for example, no material change of voltage would occur in New York, if the latter were in the same circuit. This is due to the reciprocal actions of the electromagnetic and the electrostatic characteristics involved. Thus mighty forces neutralize one another and make for the safety of an installation which otherwise would be fraught with appalling perils.

One of the most promising features of the superpower project is the opportunity that it will present to operate equipment at its full load rating for a much larger number of hours annually than under present conditions. To-day, this utilization probably does not exceed fifteen per cent. of the total capacity of the apparatus in service—the situation is like hiring a giant to do a boy's work generally.

Among our isolated manufacturing industries, it is estimated that their power plants run at full load for something like 1,300 hours per annum, whereas the equipment of a superpower system, when furnishing power to industries, should operate at full load for substantially 4,300 hours a year. In other words, it is confidently expected that the superpower zone would bring the average load factor up to 50 per cent. of the rated capacity of the gen-

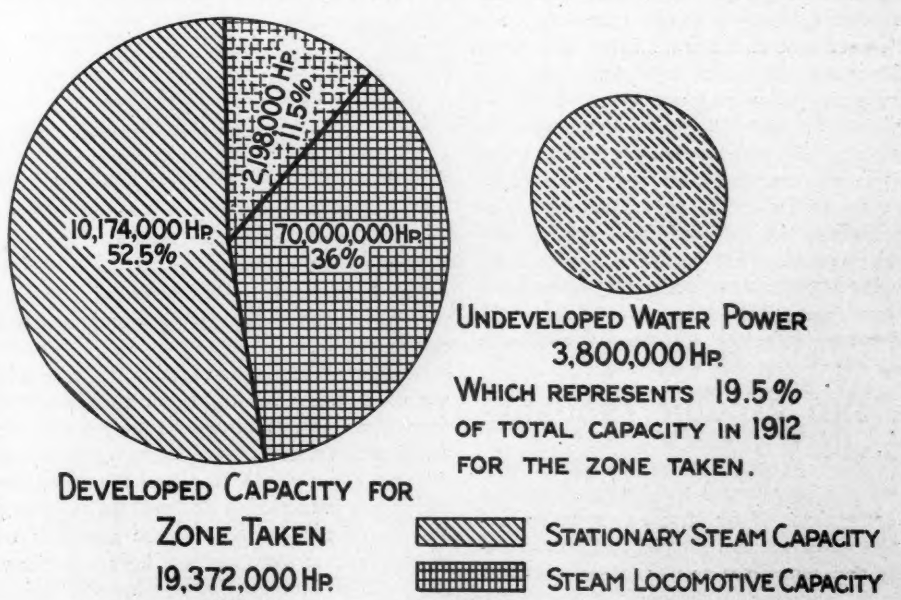


Sections of New England and Middle Atlantic States in superpower zone.

erators, improving existing conditions more than threefold. Anyone acquainted with the meaning of quantity production will appreciate the gains that the contemplated change will bring about through the reduction of fixed charges—overhead and current expenses.

It is quite conceivable that the local electric power plant in any neighborhood may be run with added profit by utilizing the otherwise slack periods to operate compressors to store up air in large quantities at a central compressed-air station—this latter plant having a system of distributing mains feeding to numerous patrons, as is the case in the City of Paris, and at the Rand mines in South Africa. This, of course, presupposes industrial conditions within the district calling for much compressed air to function divers pneumatic tools in the foundry, the factory, the shipyard, the steel mill, and, possibly, the mine.

Finally, let us see what the superpower zone will do through the locating of master stations in or contiguous to the coal fields. A recent report of the Bureau of Mines of the State of Pennsylvania discloses that for a total annual production of 80,000,000 tons of anthracite in



that commonwealth more than 8,000,000 tons are used in carrying out the mine operations. Apropos of this, one expert says: "Data obtained from the electrified mines of the district indicate that if all of the mines were electrically operated from a central supply system this 8,000,000 tons, now being used for mining coal, would be capable of supplying all the needs of the coal companies and have a balance sufficient to operate a generating system of over 600,000 kilowatts capacity at 50 per cent. load factor, or approximately the entire power load of Greater New York, including the railways."

With bituminous coal at $5.00 a ton, let us say, the practical man has no trouble in visualizing the $150,000,000 that would be saved by not burning 30,000,000 tons of that fuel. And he may even be able to grasp the fact that that coal would represent in round figures a burden for 600,000 cars. But there is another angle to the potential benefits that may follow in the train of avoiding the wasteful consumption of such a quantity of fuel. The Superpower Survey has this matter under advisement, i. e., the treatment of great quantities of bituminous coal by by-product coke ovens, and the decision will rest upon discovering ways and means by which coke can be put on the market at prices that will appeal to the average consumer. However, in the meantime, let us recall that each ton of bituminous coal is made up of 1,440 pounds of coke, 10,000 cubic feet of gas, 22 pounds of ammonium sulphate, two and one-half gallons of benzol, and nine gallons of tar. Six years ago, when soft coal was fetching only a dollar a ton at the mine, the by-products were valued at fourteen dollars.

We know full well that the day is upon us when curtailment of the industrial use of fuel oil cannot be avoided. For many reasons, which need not be gone into here, petroleum for motive purposes must be limited to certain fields of service; and we can count less confidently, as the years pass, upon a supply of natural gas to meet domestic and industrial demands. Plainly, then, coal will become our mainstay and, this, too, we must conserve. The superpower zone offers us a magnificent agency to this vital end. The men that have this matter under advisement are not theorists but technicists of wide experience and enviable standing. Their aim is to evolve facilities that will help everyone and hurt none. It will behoove the public to see to it that their ultimate findings be not lost in some departmental pigeonhole, but constitute, instead, the basis for action. Our economic future will turn in no inconsiderable measure upon whether or not we have the wisdom to insist upon putting the project into execution.

AIR AND VACUUM TROUBLES IN WATER MAINS*

NEARLY every water-works superintendent has experienced trouble in connection with some phase of air in pipes. A leaky suction pipe often reduces the plant efficiency materially and sometimes results in serious damage to the pumping machinery.

Where the discharge pipe is perfectly tight, if a small quantity of air be pumped with the water, it is likely to accumulate on the summits and appreciably reduce the capacity of the pumping main, or—what is the same thing—increase the frictional head due to the reduced cross-section of the pipe at the summits. The remedy is to prevent the ingress of air at the pumping plant, but even at the best more or less air is entrained with the water, and under reduced pressure at the summits this air may at times accumulate, and then the only remedy is to provide automatic air valves on these summits.

While the cushioning effect of air in mains often prevents serious water hammer, on the other hand its sudden escape at a high velocity, as sometimes happens, will produce serious water hammer.

The accumulation of air in summits of gravity mains has frequently resulted in the complete interruption of the supply on large portions of the system, and sometimes this phenomenon is troublesome and difficult of correction.

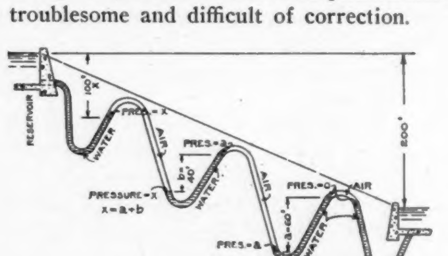


Fig. 1—Air Pockets Stop a Village Water Supply

In one case in the experience of the writer a 14-in. main extended from a distributing reservoir, at elevation 628, across a valley, the elevation of which was 150, to the opposite hill at elevation 550, where there was a considerable amount of population, and very variable topography. Branches from this main extended at right angles in both directions to lower elevations. It was found that no water could be furnished on one of these branches, as was evidenced by the complaints of the consumers. The spigots were opened in houses

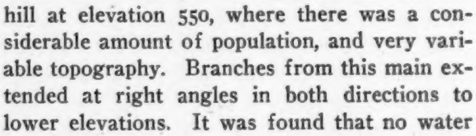


Fig. 2—An Air Pocket Stops a Railroad Supply

and the water would not flow even at the ground floor. After many hours of investigation, a pocket of air under pressure was discovered at one of the summits, and as soon as this was released the supply was immediately resumed.

Another case consisted of a 16-in. gravity main extending for eight miles from an impounding reservoir to two standpipes supplying a railroad service. It was found one afternoon that no water would flow into the standpipes, and it was immediately assumed that somebody had closed a valve or that the reservoir was empty, because there had not been experienced any trouble since the line was installed several months previously. An inspection was made; air valves were opened all along the mountain at the various summits; no water flowed and no air came out of the main. It was finally learned that on the day before a valve had been closed near the reservoir to make some slight repair on the line; on inquiry it was found that this valve had been reopened and this was verified. It had been the intention to locate automatic air valves at all the summits. One of these summits was close to the impounding reservoir. Finally this air valve was examined and to the surprise of everyone it was found disconnected and lying in the valve pit. On opening the air valve connection, the air escaped and the water began to flow freely. This particular summit was so close to the reservoir and so small as compared with the others on the line that no one suspected that trouble existed at that point.

The accompanying diagram, Fig. 1, illustrates the principle. In this case the impounding reservoir is shown 200 ft. above the distributing reservoir, and under these conditions no water can flow through the line until the air is relieved at the summits.

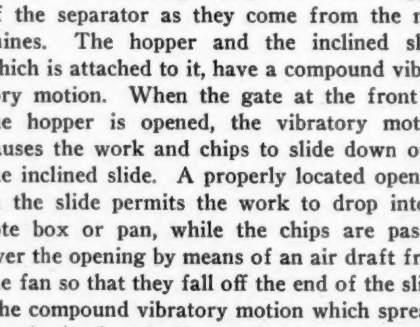
Fig. 2 illustrates about the conditions that occurred in the gravity supply to the railroad tanks

*By J. W. Ledoux, Consulting Engineer, Philadelphia. Abstract of paper at Annual Convention of New England Water Works Association.

PNEUMATIC CHIP SEPARATOR

The machine here shown performs an important service in a manufacturing machine shop. It separates the chips from the small articles which are the product of automatic machines and with one operator it can do as much as three men with riddles, or as much as six men picking by hand.

The work and chips are placed in the hopper of the separator as they come from the machines. The hopper and the inclined slide which is attached to it, have a compound vibratory motion. When the gate at the front of the hopper is opened, the vibratory motion causes the work and chips to slide down over the inclined slide. A properly located opening in the slide permits the work to drop into a tote box or pan, while the chips are passed over the opening by means of an air draft from the fan so that they fall off the end of the slide. The compound vibratory motion which spreads out the work and chips as they come down the slide permits a light air draft from the fan to



Pneumatic Chip Separator

float the chips over an opening in the slide through which the work drops; this method of separating the chips requires a much lighter air draft than would be needed if the chips were blown up into the air, and at the same time effects a satisfactory separation of chips from small as well as large work. It is built by the Ideal Concrete Machinery Co., Cincinnati.

Modern Pneumatic Caisson Practice

A Discussion of the Uses of a Vitally Important Engineering Device under Varying Conditions—Under Water, in Mud, Quicksand, Gravel and Rock—Celebrated Instances of its Application

By FRANK W. SKINNER

WHEN IT is required, as is so often the case on important engineering schemes to do construction work or excavation below the surface of the ground and also below water level, the operations are likely to be uncertain, slow, costly and sometimes dangerous unless they can be conducted from the surface with more or less automatic appliances. This is the case in ordinary or bucket dredging or by pile driving which, when under suitable conditions and acceptable for the requirements, enables foundations, the most ordinary of subterranean constructions, to be built at a considerable depth and in soft wet ground that is difficult to make accessible to the bottom of the foundation.

If the depth is not too great, and the character of the soil will permit the use of ordinary methods, the site may be enclosed by various kinds of cofferdams from which the water may be pumped out, exposing the bottom and permitting the work to be carried on there. If, however, the depth is great or the soil is of a difficult character, or if many obstructions occur in it such as boilers, old foundations, sunken boats and the like; if boulder stratum or hardpan has to be penetrated; if the bottom has to be prepared on irregular or unsound rock; or if water rises abundantly through water bearing strata, thus entering the cofferdam from the bottom, or if the safety of adjacent structures is threatened by the subterranean movement of earth or quicksand; or if the material encountered is unstable, it may be impracticable or impossible to make the required open excavation.

In most cases of this nature, it is possible to do the work by the pneumatic caisson process which is applicable under water, in mud, quicksand, gravel, rock or any combinations of such materials and enables workmen to descend and excavate and build at any point within limits regardless of the character of the strata above or below them.

The pneumatic caisson is substantially a movable workroom that can be shifted from position to position underground, enabling excavation and construction work to be carried on progressively until the structure is completed.

Pneumatic caisson work requires skilled direction, and an abundance of suitable equipment most of which, however, is standard for ordinary heavy construction. It generally is, or can be made, safe and reliable and always gives positive and unmistakeable results on which the engineer can thoroughly rely. Limitations and restrictions necessarily govern the work and make it costly as compared with ordinary open excavation operations, but it is many times indispensable and by its means, results can be obtained that would be impossible without it. In other cases, the safety and positive results that are assured, together with other advantages, sometimes make the pneumatic caisson method expedient even when the work might possibly be done without resorting to it.

In the perfection of designs of wooden, steel and reinforced concrete caissons, and in the provision of efficient working devices, much credit is due to the Foundation Company, the O'Rourke Construction Company, the O'Rourke Engineering Construction Company, the Underpinning and Foundation Company, P. C. Bryson, and Fraser, Brace & Company, all of New York; Holbrook, Cabot & Rollins of Boston; the Dravo Contracting Company, Pittsburgh, and Arthur McMullen who have executed a large part of the work mentioned in this article and have obtained results unexcelled anywhere in the world.

Pneumatic caissons are built on the following scientific principles: that fluid pressures must equalize each other: that two fluids cannot occupy the same space at the same time; and that fluids of light specific gravity will maintain their position above those of heavier gravity. In other words a closed chamber cannot be filled with air and water at the same time. Therefore if air is maintained in it, water cannot enter and the men can work in it with safety.

The principle is clearly demonstrated by inverting a tumbler in a pan of water when it will be observed that the water rises only a short distance above the bottom of the tumbler, slightly compressing the air within to equalize the pressure with that of the outside water at the bottom of the glass. The amount of this pressure increases more and more and the air space is reduced as the tumbler is sunk deeper and deeper below the surface.

This is the principle of the diving bell, which is simply an air tight chamber in which men are safely lowered below the surface of the water. In the diving bell, the water, however, always rises more and more above the bottom of the bell the deeper the latter is lowered, until at the extreme limit in which pneumatic caisson work can be conducted, the water would occupy three-fourths or more of the bottom if the bell and the air were confined in the extreme upper portion.

In the pneumatic caisson, the diving bell principle is modified by forcing in additional air in proportion to the depth descended so as to maintain the original volume at increased pressure and thereby prevent the rise of water above the open lower part of the caisson.

While the diving bell is supported, shifted and raised from above and is removed after its work is completed, the pneumatic caisson is never raised or removed but forms part of the permanent construction and is generally sunk through solid material below the original surface of the bottom. Excavating and construction are both conducted in it and means are therefore provided for the ingress and egress of men and materials.

The pneumatic caisson consists essentially of an air-tight bottomless chamber provided with an air-tight shaft opening at the bottom in the roof of the chamber and extending above water level. A compartment called an air lock that has one door opening into the shaft and another opening into the exterior air, either of which may be opened when the other is closed but never both opened together when the caisson is in service is also provided.

This permits communication with the pneumatic caisson at the expense of only the compressed air contained in the air lock. Powerful pumps are provided to force compressed air to the pneumatic caisson, and hydraulic pipes, blow-off pipes, electric conduit, telephones and signals are usually provided for the service of the workmen.

In most cases, the pneumatic caisson serves as the foundation for a superstructure which is built on it before it is sunk to position or is built while it is being sunk and is then protected by a permanent or temporary cofferdam enclosing it and attached to a caisson.

Caissons are usually sunk by interior excavation, including blasting when necessary, the heavy caissons loaded with a superstructure and sometimes with additional temporary ballast.

Stones, timber and other solid materials are removed in buckets hoisted through the air-shaft and air-lock by derricks located outside the caisson but soft materials like mud and sand can be continually ejected by the interior air pressure forcing them through an open pipe with the lower end immersed in a pool of water in the caisson and the upper end discharging over the top of the caisson above the surface of the water.

Caissons must be designed to resist the heavy stresses occasioned by unequal support while sinking; the force of waves, wind and current when sunk through water, and the great weight of the superstructure or the temporary ballast used to force it down. Caissons are sometimes 100 feet or more in width or length and when they become heavy require a great amount of bracing.

The space beneath the roof of the caisson, known as the working chamber is restricted,

conditions are uncomfortable, and work is done at a disadvantage. These factors together with the restrictions of receiving and removing materials through the air locks make it more slow and more costly as the caisson descends farther and farther below the water level. As greater depths are attained, increasingly strict precautions are necessary to preserve the workmen from the effects of higher air pressures, and they are, in this country, prevented by law, from working too long at one time until at a great depth they may be permitted to work only a few minutes at once. Then, after several hours' rest, another period of the same length in each 24 hours is permitted for which these workmen receive as much, or more pay, as for working a full eight-hour shift under normal conditions.

If men are fit for the work, observe proper regulations, and are properly cared for, they can work with little danger as deep as 100 feet below water level where the pressure will be about 45 pounds per square inch.

Pneumatic caissons can be made with any required plan or cross section, but usually conform to that of the superstructure or section of the superstructure which they support and in most cases are rectangular except for small piers, especially in buildings or pivot piers of drawbridges. Sometimes for shafts or wells which are frequently circular, a type is used which develops the least possible friction and is best suited to resist external pressure. Octagonal or irregular cross sections are also sometimes used.

At first, the cross section was sometimes made smaller at the top than at the bottom so as to purposely provide a type that was thought would diminish the friction and facilitate sinking. However, it is now generally agreed that little is gained in this manner and more is lost on account of the difficulty of maintaining the caisson plumb as it is sunk so therefore it is usually constructed with vertical exterior walls.

The structure to the top of the prominent exterior walls is generally called a caisson but, strictly speaking, the caisson may be limited to the lower portion only in which the pneumatic pressure is applied and which sometimes constitutes the whole structure. Generally, however, this lower portion consists of a working chamber from five to seven feet in height provided with air tight walls and roof and having the exterior walls extended if necessary from the roof of the working chamber to the point where the superstructure proper begins, often just above the water or ground water level.

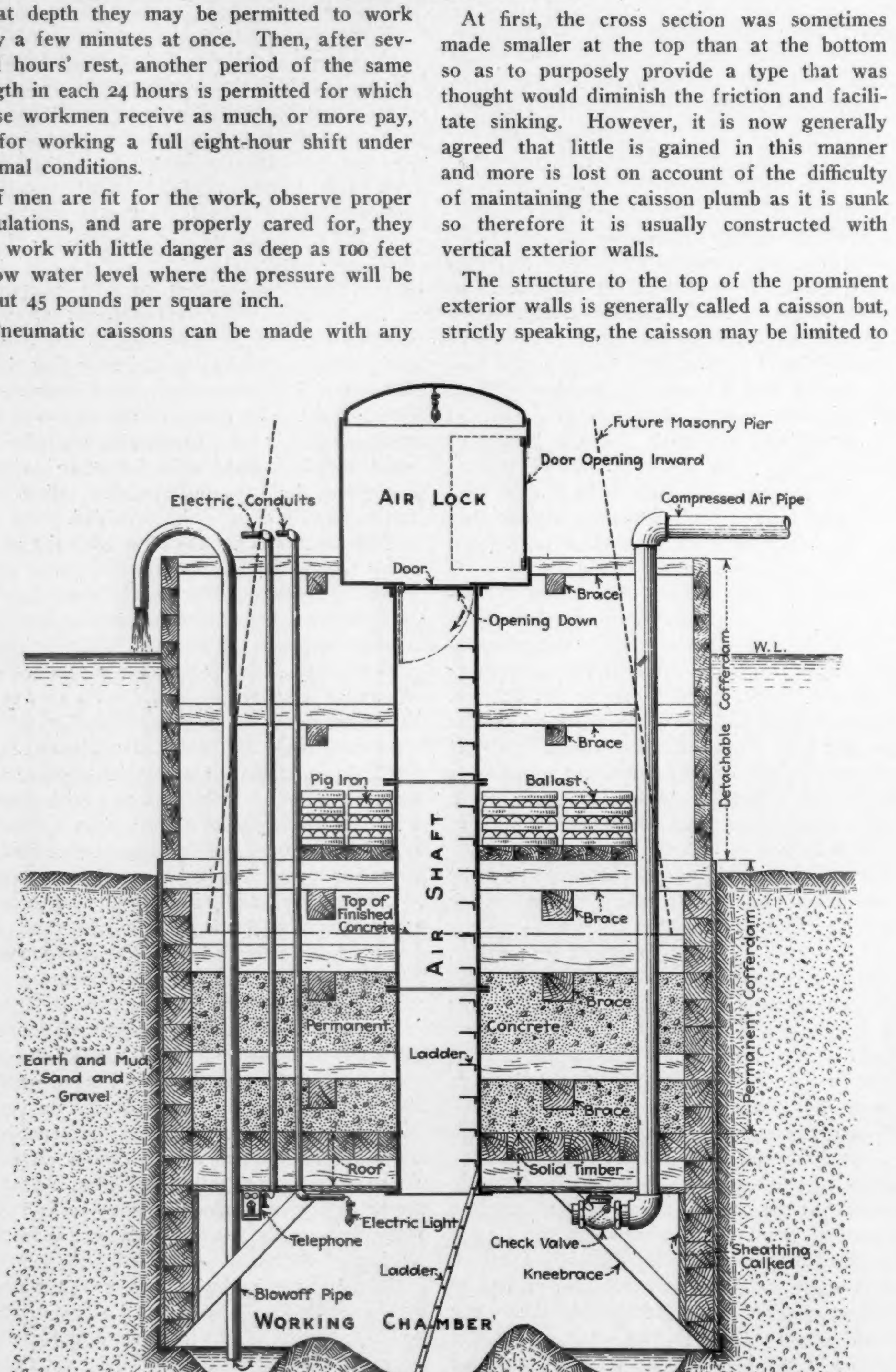
This arrangement is virtually that of a cofferdam built integral with the caisson walls and permits the caisson to be sunk as rapidly as possible without waiting for the completion of the upper part of the foundation until a convenient time. Sometimes, the prominent upper walls do not reach to the water level and are supplemented by the attachable cofferdam walls which are usually of timber, and extend above water level.

In some cases foundations or other portions of the duct structure are solid masses of concrete built virtually integral with the roof of the working chamber. These extend up to or near the water level, practically making the caisson consist of solid masonry, pierced only with the working shafts and hollowed out at the base for the working chamber. In the latter case the upper part must either be built before the caisson is sunk or be built as rapidly as it is sunk so that work may go on above level as there is no protecting cofferdam to exclude the water. The last method is becoming more common and has the advantage of affording great weight to assist in sinking the caisson without involving the use of temporary construction, or rehandling of materials.

If the caisson roof is not integral with the remainder of the substructure, it is likely to have to sustain a heavy load and for large caissons or high structure it is made extremely strong. This is accomplished either by having a great thickness, by being trussed, or frequently by being supported intermediately by cross walls passing through the working chamber.

The roof and shaft, if there be one, are pierced with one or more air tight steel cylinders usually about three feet in diameter which are opened at the bottom into the working chamber and are always carried up above water level. They generally terminate with the double-door air-lock, through which materials may pass in either direction with minimum escape of air pressure. On rare occasions the air locks are located in the bottoms of the shafts, or the shafts may be closed for special purposes by a bottom door. Usually, however, the air locks are attached to the tops of the shafts, and the latter are either made full length before sinking is commenced, or are provided with lower doors enabling the air lock to be removed and additional sections of the shaft inserted as the work progresses.

In large caissons the air shafts are usually permanently embedded in the concrete, although in smaller caissons and especially for buildings they are often made collapsible and removed after the caisson is sunk to position and the working chamber is filled with concrete. In any case they are securely anchored to the roof of the working chamber to resist



Conventional wooden pneumatic caisson.

the upward force of the air pressure.

For large or heavily loaded caissons the exterior walls are made thick to secure the necessary strength. Therefore, in order to make it accessible for excavating under them, the lower edge is usually made as narrow as possible and generally shod with steel called a cutting edge, from one to six inches in width, from which the inner wall slopes inward to the top which may be from one to five feet in thickness. If the walls are not thickened in this manner as may be the case with single-plate steel walls, they are heavily knee-braced to the roof.

When caissons are located on dry land, ditches are usually excavated for them down to the ground water level or to a convenient depth, and in them the cutting edge is laid and the caisson built up *in situ*. When caissons are sunk through water, artificial islands are sometimes built, on which they are constructed as though on dry land, or at other times the lower part is constructed on false work platforms and lowered to position as the upper portions are built on.

In other instances they are built on scows, which are sunk under them leaving them floating and often they are built on ship ways on shore and when partly complete are launched, finished while floating, towed to position and sunk. When the water is deep, the caissons present a large surface to current and wave action, often making necessary the protection of temporary fender piers and that they be securely anchored until they have been sunk to a considerable penetration in the bottom.

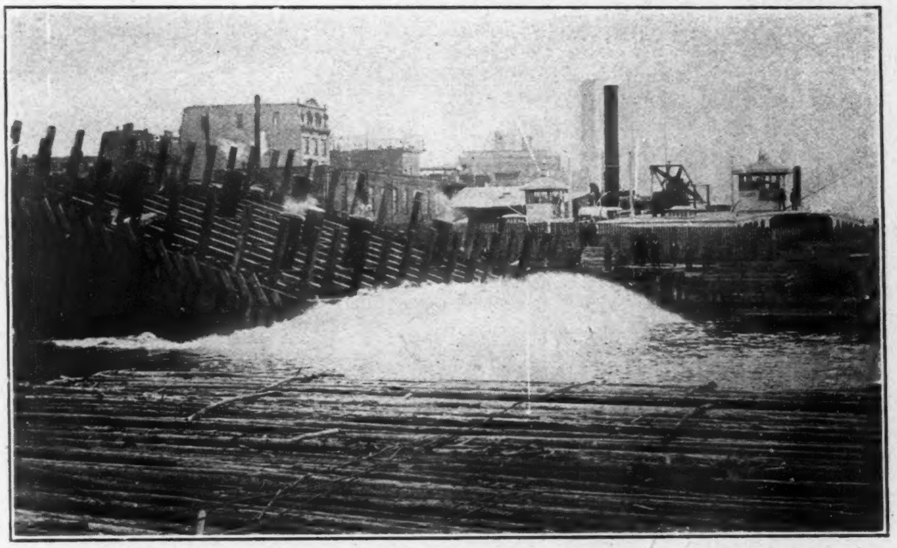
Under favorable conditions where the bottom is soft, considerable time and money may be saved by dredging for a large caisson before it is landed in position. When the caisson is landed in position and properly secured against lateral displacement, all the air shafts and other outlets through the roof of the working chamber are closed and air is pumped in through the supply mains which are usually closed with a check valve or flap valve on the horizontal lower end. Then the gradual filling of the chamber from the top down, displaces the water that escapes under the cutting edge until the inside of the cutting edge is out of water at the highest point, if it is not absolutely level; afterwards the addition of more air will cause it to escape under the cutting edge at the highest point.

Water cannot enter the chamber above the highest point of the cutting edge until an equal volume of air under balanced pressure has been displaced and if any air leakage occurs and is not made up, the water will gradually follow it. Therefore great pains are taken to make the working chamber air tight and keep it so. If there are irregularities of the bearing of the cutting edge, as is generally the case, and the air tends to escape at any given point more than it does elsewhere, as is indicated by a whistling noise, the leaks often may be stopped with puddled clay applied from the interior.

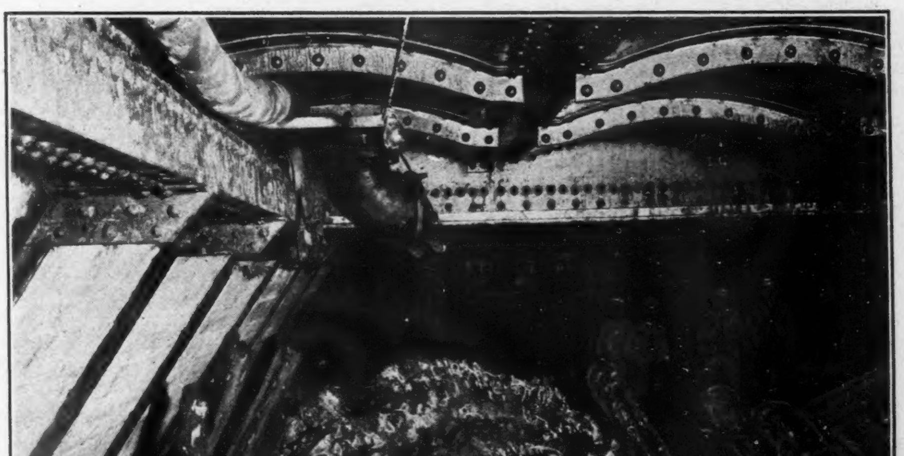
Men entering the working chamber through the air lock and air shaft excavate the bottom by hand, using buckets for loading material, blasting rock if necessary, and cutting through logs, timbers and the like with axes or boring into them and shattering them with light charges of dynamite if they extend under the cutting edge.

In soft bottom, the weight of the caisson is at first likely to make it descend a little faster than the excavation is made, so that the cutting edge for a time seals itself in the mud or sand. As the caisson descends the friction on the exterior rapidly becomes greater and is soon likely to be sufficient to arrest the descent until the support is nearly or entirely removed from under the cutting edge, when it is likely to come down by jumps. As the caisson descends deeper, it is generally necessary to force it down by added weights either of permanent structure or by temporary ballast piled on top, inside the cofferdam.

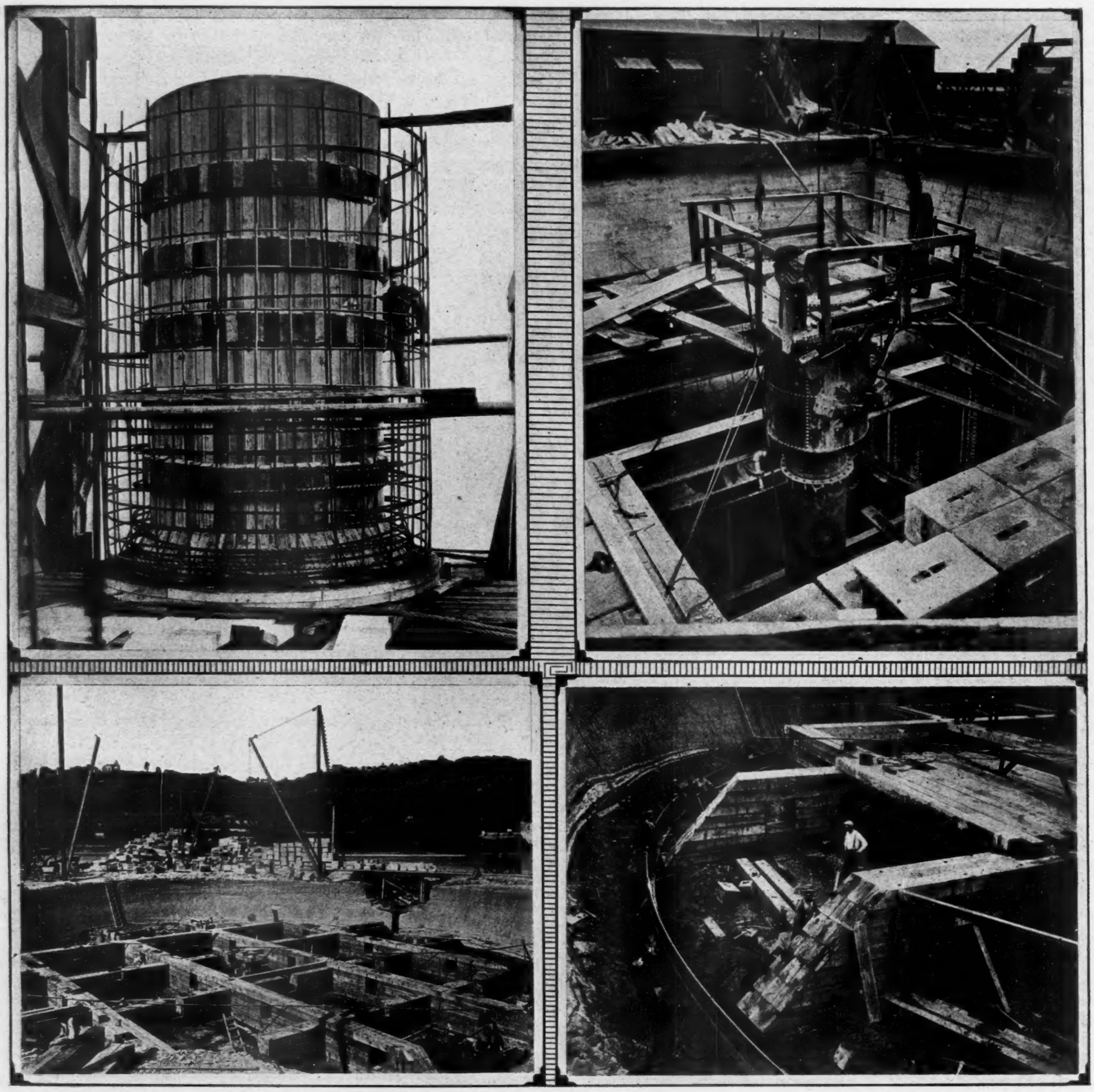
Sometimes, but not often, hydraulic jets are operated on the exterior walls of the caisson and around the cutting edge to lubricate them and scour away the earth and thus promote the descent. If the caisson begins to incline from



Launching partly finished caisson for Williamsburg Bridge, N. Y., pier foundation.



Exterior of working chamber of pneumatic caisson for 14th Street, New York, tunnel shaft under pressure. Showing detachable heavy buckle plate roof, inlet valve at foot of pressure pipe, and timber from old sunken cribs encountered in excavation.



Upper left: Inside wooden forms and steel reinforcement framework suspended from falsework tower on bank of Patapsco river. Upper right: Air shaft lock and operator's platform for pneumatic caisson of 14th Street tunnel shaft, New York. Bottom left: Bulkhead girders in working chamber ready to receive roof for pneumatic caisson of California pump well, Cincinnati. Lower right: Building bulkhead in working chamber of pneumatic caisson for California pump well, Cincinnati. Circular steel cutting edge shown in position at bottom of excavation in which caisson was built.

the vertical, efforts should instantly be made to restore it to plumb, usually by digging under the high side and loading ballast over it and sometimes by setting up inclined braces under the roof of the working chamber to carry it transversely as it descends.

As the bouyant effect of the compressed air in the working chamber is large, the descent of the caisson on land or under water is greatly facilitated by "blowing off" so as to suddenly reduce the pressure several pounds which may result in the drop of the caisson a number of feet if the excavation has been continued so far below the cutting edge.

To permit the entrance of workmen into the working chamber the lower door of a man lock at the top of an airshaft is closed, a vent pipe in the lock is opened, and the air pressure allowed to escape. When it is equalized with the exterior atmosphere the upper door can be opened, the men enter and the door and vent valve are closed.

The pressure valve is then opened either directly from the main or from the air shaft that communicates freely with the working chamber and the air rushes violently in with a loud hissing noise. It produces a disagreeable effect, like that of water filling the ears, which can be relieved by tightly pinching the nostrils and then trying to expel air from the lungs through them, and by repeated swallowing.

Ordinarily no farther inconvenience is experienced, and no great discomfort is felt. The lower door in the lock can then be opened. Then it is easy to descend a ladder in the shaft and so reach the working chamber. Here the "sand hogs" will be found digging, shoveling, picking, drilling, blasting or chopping by electric light in a misty atmosphere, the temperature of which varies from 70 to 100 degrees according to the depth below water level. The air is sometimes cooled by leading the air supply through a coil surrounded by cold water. Long exposure to heavy pressure is undesirable, but the principal danger is in rapidly emerging from heavy pressure. If the pressure exceeds fifteen pounds per square inch, it ought not to be lowered more rapidly than one pound per minute, and not even so rapidly as that if the pressure is very heavy. The usual tendency of the sand hogs is to hasten

through the air lock at maximum speed, regardless of safety. To prevent it, reliable guards are stationed outside to control the valves and an ingenious valve has been patented by Walton L. Aims to regulate the flow and prevent undue haste in decompression.

The working time in a pneumatic caisson varies from one eight-hour shift per day when the pressure is not greater than five or ten pounds to a minimum of two 40-minute shifts per day with a three-hour rest interval between them as prescribed by the laws of New York State. About 110 feet is the maximum depth that has been attained by pneumatic caisson work in America, but experimental researches of foreign scientists have led them to believe that with great care and with proper restrictions, men could safely endure a pressure to a depth of 170 feet or more below water level, although of course they should not remain long in it or work violently there.

The most numerous applications of pneumatic caissons are for the construction of foundations for bridge piers and for buildings but they have also been used for many other purposes, chiefly for building deep substructures in soft or wet ground, and in sinking foundations for lighthouses, for quays and sea walls, for the construction of tunnels, tunnel shafts and wells, underground chambers, subways and subway stations, for the construction of pumping or intake wells, dam foundations, cofferdams, underpinning, and for other special purposes.

The use of pneumatic caissons for constructing foundation of bridge piers under water and sometimes on shore adjacent to the water, are so numerous that only a few of the more important need be described as may be recalled.

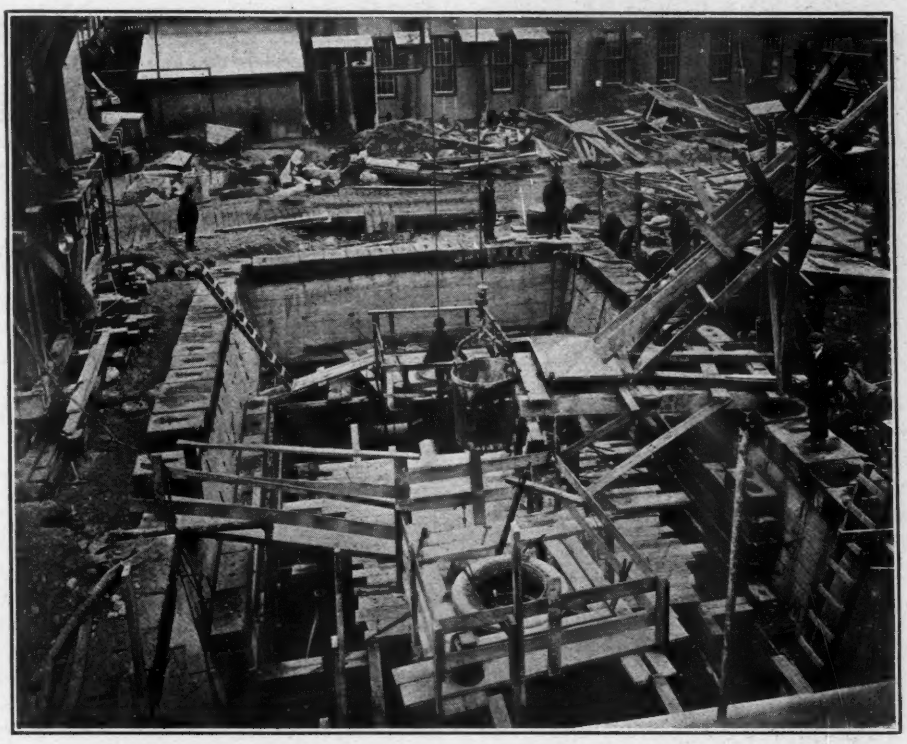
Pneumatic caissons were an important and costly factor in completing the construction of the railroad bridge across the St. Lawrence river at Cornwall Island after the collapse of one of the piers.

The wrecked spans were removed by dynamiting and by an ingenious and courageous method of floating under water, supported by air-tight buoyancy cylinders attached to the steel work by divers.

The wrecked portion of the bridge was rebuilt on the same site and with spans of the same length, thus necessitating the construction of a new pier on the site of the wrecked pier. At this point the current was so violent that it would immediately break off large wooden piles driven in the bottom. Therefore to protect the site, large piles were driven in clusters braced by the pile-driver boat until they could be chained together in clusters, thus developing strength enough to resist the current.

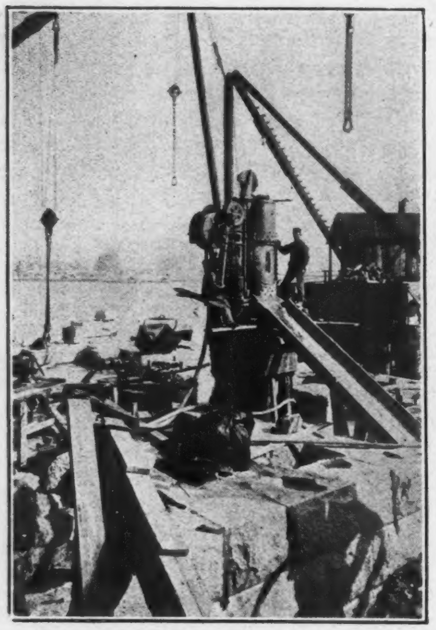
A wooden pneumatic caisson was built on shore, launched and towed to position under protection of these pile breakwaters, and was securely moored and sunk on the rims of the old crib. Notwithstanding that the current was so fierce that the divers could not descend to make the necessary observations and work under water except under protection of heavy steel shields strongly guyed, the caisson was safely located and held in position while compressed air was forced into the working chamber and expelled the water, and while the cutting edge resting at two or three points on the debris of the pier was still many feet above the bottom of the river.

The timber of the old crib projecting upward at opposite angles of 45 degrees and embedded in a huge mass of concrete formed an obstacle through which it was necessary to sink the caisson. Notwithstanding the tremendous water pressure, the engineers and workmen entered the caisson and began the slow task of cutting away the heavy crib timbers which were sawed, chopped with axes, and, where they were under the cutting edge of the caisson were bored with long ship augers by men that reached under water and beyond the working chamber and made holes for dynamite cartridges. These cartridges were inserted and fired, shattering the timber and gradually breaking it away so that the caisson descended a few inches each day.



Sinking pneumatic caisson for Manhattan shaft of 14th Street tunnel, New York. Caisson walls loaded with special cast iron ballast blocks.

Pneumatic caisson enclosing Cornwall bridge pier completed, assembling steel cofferdams above roof of working chamber.



Detail of special material lock installed on top of air shaft for Williamsburg Bridge pier caisson.

Instead of being a dark, muddy and slimy cavern, as is usually the case, the interior of this caisson was light and clean and the transparent green waters of the mighty St. Lawrence could be seen rushing violently below the cutting edge and all around the caisson.

Under the circumstances, of course, the cutting edge could not be sealed and there was a tremendous loss of air pressure continually breaking out under the cutting edge with a roaring, crashing noise that was alarming. Eventually, the caisson was sunk through the old ruins and to a secure foundation far below the bottom of the river; the pier was rebuilt on it, and the spans were safely reërected.

This, however, was only one of the parts that pneumatic caissons played in the construction of this bridge. On the opposite side of Cornwall Island the long swing span of the bridge was supported on a 50x14-foot pier, 65 feet high on a 17x61-foot concrete-filled timber crib, 21 feet high, located in water 26 feet deep but with a velocity of only three miles per hour.

Here again the apparently hard bottom was soft underneath, and the pier soon began to settle so that although it did not entirely fail, the condition was considered dangerous and it was safeguarded by enlarging it so that its pressure on the bottom was reduced and the settling was checked. To accomplish this the bottom of the pier was enclosed completely by an annular steel pneumatic caisson, 84 feet long, 36 feet wide and ten feet high, with double walls seven feet apart.

The caisson and cofferdam were assembled in two longitudinal halves on scows which were moored to the pier and supported the caisson while the two sides were securely riveted together. The caisson was then suspended from the floor of the great span above, the scows removed and the caisson sunk by interior excavation through the rip rap that surrounded the old pier, until its cutting edge was three feet below the original surface of the river bottom.

Holes were then drilled below water level through the old pier and steel cables inserted in them and tightly stretched between girders in the caisson. The caisson was concreted solid, the water pumped out of the cofferdam and out of the space between the caisson and the old pier, and the latter space was also filled solid with concrete thus making a homogeneous structure of the old and new work and reducing the foundation pressure so much that the pier has been maintained in safety ever since.

The Bronx river viaduct approach to the famous Hell Gate Bridge, New York, has plate girder spans supported on 91 reinforced concrete cylindrical pneumatic caisson piers from ten to eighteen feet in diameter. These were sunk by open dredging through eight to twelve feet of fill and 25 feet of impervious blue clay and eight to ten feet of quicksand to rock. After the construction of the caissons above the surface of the ground in pits at water level about four feet below the surface, excavation in them was carried on by the dredging buckets until the cutting edge reached the quicksand, when the dredging wells were closed, air shafts and air locks installed, and the remainder of the excavation accomplished under air pressure. This is probably the largest number of caissons ever handled by this combined dredging and united caisson method for one job.

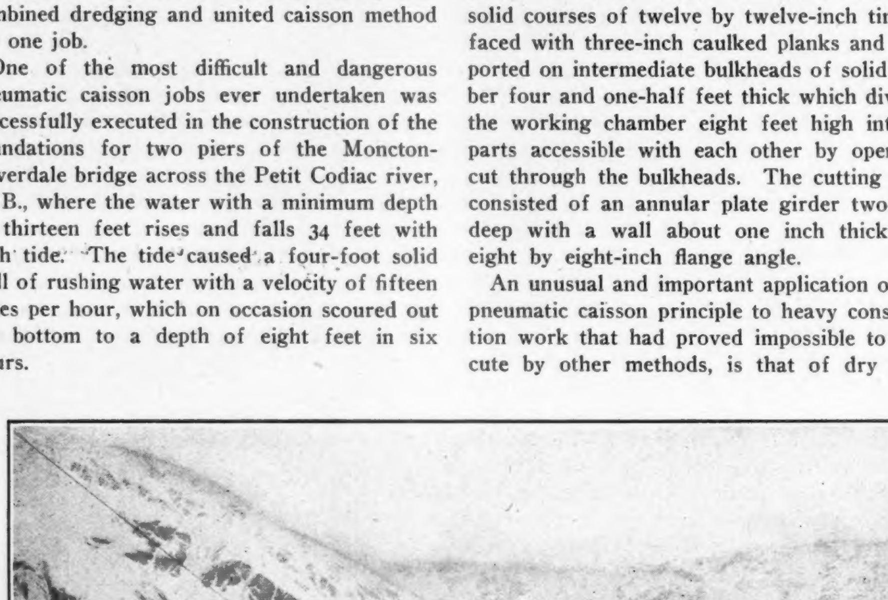
One of the most difficult and dangerous pneumatic caisson jobs ever undertaken was successfully executed in the construction of the foundations for two piers of the Moncton-Coverdale bridge across the Petit Codiac river, N. B., where the water with a minimum depth of thirteen feet rises and falls 34 feet with each tide. The tide caused a four-foot solid wall of rushing water with a velocity of fifteen miles per hour, which on occasion scoured out the bottom to a depth of eight feet in six hours.

The caissons, of heavy wooden construction, eighteen feet wide, 68 feet long and 24 feet high, were built on shore, launched and towed to position in which operation one of them broke loose, was wrecked and had to be replaced. The conditions were so severe that the sand hogs could only work at low tide for a short time and at high tide the working chamber was sometimes completely filled with silt. An air supply of 2,500 cubic feet per minute was required but the work was steadily carried forward to a successful completion and the caissons sunk twenty feet through sand, gravel and boulders to rock stratum without loss of life or serious accident.

The California pump well for the Cincimmati water works has a deep circular stone wall containing the 4,300,000 gallon pumps at an elevation of about 95 feet below the surface of the ground. In the center of this chamber a shaft seven and one-half feet in diameter extends to a depth of 155 feet below the surface to receive the intake water.

The walls of the main shaft were built on the roof of a massive wooden pneumatic caisson, 130 feet in diameter and twenty feet high, built in position and sunk to a depth of about 115 feet. The circular wall of the caisson and of the steel cofferdam 95 feet high that surrounded it were battered one and one-half to twelve. The caisson was of extraordinarily heavy construction with a roof made of twelve solid courses of twelve by twelve-inch timber, faced with three-inch caulked planks and supported on intermediate bulkheads of solid timber four and one-half feet thick which divided the working chamber eight feet high into 21 parts accessible with each other by openings cut through the bulkheads. The cutting edge consisted of an annular plate girder two feet deep with a wall about one inch thick and eight by eight-inch flange angle.

An unusual and important application of the pneumatic caisson principle to heavy construction work that had proved impossible to execute by other methods, is that of dry dock



Sinking wooden pneumatic caisson through artificial island in Copper River near Wilez glacier.

No. 4 in the Brooklyn Navy Yard that was under construction for several years and involved great loss of time and money before the pneumatic caisson method was adapted.

The original dimensions of this dock were 542 by 130 feet by 40 feet deep, with a concrete bottom on pile foundation in quicksand close to the river shore. Attempts were made to excavate for the dry dock in a cofferdam made of massive wooden sheet piles driven below the required bottom.

As the excavation proceeded the quicksand flowed under the bottoms of the long piles producing serious settlements in the surface of the ground far beyond the cofferdam, and threatening to injure the existing structures in the Navy Yard. The original contract was partly abandoned and re-let and the second contractor, after spending a large amount of money, was also obliged to abandon it.

Eventually the original plans and methods were discarded, and the size of the dock was increased to admit a ship 680 feet long, of 50,000 tons capacity. The heavy concrete walls were made in sections joined together to form a continuous structure which like the floor slab eight feet thick was supported on pneumatic caissons.

The walls were built with 51 rectangular wooden pneumatic caissons made integral with permanent wooden cofferdams that served as forms in which the concrete was placed before the caissons were sunk. The foundations for the floor of the dry dock were required not only to support the weight of the slabs but since that was less than the unbalanced pressure of the ground water, they had also to serve as anchorages against uplift. The floor slabs were heavily reinforced to resist bending and also to enable them to utilize the weight of the side walls.

There were 106 seven by seven-foot interior floor caissons sunk to a depth of 45 feet below the bottom of the excavation. After reaching satisfactory bearing and completing the sinking of these caissons their outer walls were removed in successive small sections permitting the excavation to be extended beyond the cutting edge for a distance of three feet deep below it and two feet horizontally outside of it, thus making flanges or extended footings with inclined surfaces resisting upward displacement and adapted to react against the heavy mass of quicksand above the cutting edge. These caissons were filled with concrete placed integral with that placed in the floor slabs.

The tallest wall caisson was 95 feet high. All the caissons were built up to a height of 70 feet, as far as could be conveniently handled by the locomotive crane, before sinking was commenced. After they had been sunk 30 feet or more, the upper part of the concrete was built on before, the sinking was completed. A large amount of the ballast was required to overcome the skin friction which was computed to be about 700 pounds per square foot of vertical setting. After the wall caissons were separately sunk they were connected together and the joints made water tight with vertical concrete keys filled into recesses left in the ends of adjacent caissons, in a manner similar to that frequently used for the caissons supporting the exterior walls of tall buildings in New York City.

A striking application of pneumatic caissons to cofferdam construction was in the case of the Hauser Lake Dam reconstruction. This dam 490 feet long, 132 feet high, and 85 thick at the base, was built on the site of a wrecked steel dam where the bottom consisted of 45 feet of boulders, sand, and gravel overlying rock from fifteen to 65 feet below water level. The site was greatly obstructed by the wreckage, and as the irregularities and holes in the river bottom were difficult to build on, a portion of the new structure was enclosed in a cofferdam containing, in its walls, seven 22 by 40-foot wooden pneumatic caissons, twelve feet high, with the walls and roofs made of one course and of three courses, respectively, of twelve by twelve-inch timbers, the walls being continued twelve feet above the roof of the working chamber to form the upper part of the cofferdam. The caissons were sunk under a maximum air pressure of 28 pounds and to resist the enormous external unbalanced pressure were braced by twelve solid timber struts, eight feet square in cross section and 60 feet long.

MINIATURE FREIGHT TRAIN HAS NOVEL COMPRESSOR

AN UNUSUAL amount of interest is being created as a result of the appearance of the Horse Shoe Cord Special, the miniature railway train that has been traversing the highways of California in recent months.

The air pump is the outstanding feature that is attracting much attention. The air pump is shown by the arrow in Fig. 1 and 2. This pump and a combined water and oil pump are operated by the small engine shown at A, Fig. 1. The engineer starts and stops the engine, but a special spring stops the air compressor when the air pressure reaches 140 lbs. Compressed air is used in operating the brakes, and in filling the tires on the train. The fuel oil is under air pressure of 120 lbs., which forces the oil into the pressure tank, a special valve being arranged between the pressure tank and the oil burner, which regulates the oil feed. The boiler can operate on gasoline, distillate, coal oil, or fuel oil. The compressed air is carried in a tank of four cubic feet capacity carried under the cab. The air is used to operate

Fig. 1—Engine cab of the Horse Shoe Cord Special.

the air brakes, which apply the brakes to the freight car and the caboose when the brakes are applied to the locomotive. The brakes are so efficient that the train can be stopped within its length when traveling at 30 miles an hour.

For filling the tires, a special air hose is carried which is connected to the air pump.

The train was originated by Roy R. Meads and L. S. Rounsavelle of the Pacific Rubber Company, of Los Angeles, Coast distributors of the Horse Shoe special tires.

It is composed of a locomotive, tender, box car and caboose, and because of its automative power is well adapted to travel over the road ways.

The train is 40 feet long and the most serious problem confronting its operators has been the regulation of traffic in cities. The designer has closely followed railroad shop building as may be seen by the minute details carefully worked out.

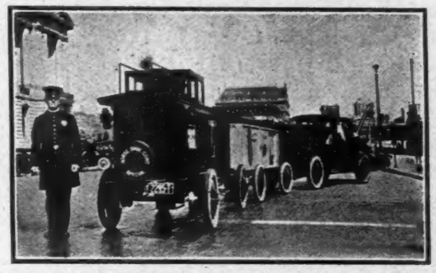


Fig. 2—Miniature freight train showing air pump indicated at arrow.

That the train is attracting the attention for which it is intended, is putting it mildly—it is a riot. Crowds gather around it large enough to impede traffic, whenever it stops. It is unique in the field of American advertising and is called the Horse Shoe Special. The sponsors hope to send it to other states in the interest of the Horse Shoe tires.

The train carries advertising matter in the box car, and in the caboose there has been installed chime bells operated by electricity and played by a lady musician in the caboose, which draws instant attention of motorists and pedestrians.

A NEW ALCOHOL FROM OIL—NOT POTABLE

A new alcohol from oil gases that can be produced cheaper than either wood or grain alcohol and used for any purpose to which the other two are adapted except medicines is on the market in commercial quantities. The new alcohol is called "Petrohol." It is used as a solvent by the dye, rubber and varnish industries. Standard of New Jersey has commenced the manufacture of Petrohol on a large scale at its Bayway, N. J., refining plant. Petrohol is made from a new alcohol contained in gases arising from the cracking process in refining crude oil. This alcohol is Iso-Propyl. While its existence has been known for some time by petroleum chemists it has, heretofore, been made only in small quantities, synthetically, from acetone.

The construction of the oil pipe line from Le Havre to Paris is now under way. Trenching work is to be done with special machines acquired by the French Government from the surplus stores left behind by the U. S. Army. All the pipes, oil tanks and pumps are to be sent from America. The oil supply by the new pipe line is to be inaugurated in December, 1921.

The Ore Mining and Metallurgical Industry of Japan

A German Engineer's Summary of Japanese Metal Development During and Since the War, with Statistics on Output

By A. W. PAUL
Translated by H. Brinkmann.

WHEN AT THE beginning of the war the prices for metals declined affecting adversely the respective industries, gold mining experienced an enhanced activity and the output of this precious metal was raised from 11,500 pounds in 1913 to 17,000 pounds in 1915. However, when in 1915 the high business prospects in the metal market set in with enormously accruing profits, the gold output became slacker and it was not till 1919 that an increased activity showed itself, for which the Hokkaido washing plant has been mainly responsible. Not more than two per cent of the gold output of the world is furnished by Japan.

Also, in silver, Japan furnishes not more than perhaps two per cent. of the world output. Since the price of silver went up by leaps and bounds during the war, silver production proved to be a most profitable business. The principal gold and silver yielding mines with their output for the year 1917 are given hereunder in kilogrammes:

	Silver	*Gold*
Kuhara Mining Co..........	60,000	2,302
Mitsubishi & Co............	48,000	475
Furukawa & Co............	31,000	195
Fujita Mining Co...........	25,500	742
Mitsui Mining Co.	7,500	862

Platinum is extracted in small quantities and principally at Hokkaido, likewise the metal osmiridium. Of the latter, the yearly output amounts to about twenty to 40 pounds. The price of plating in 1914 being about four yen per gramme, it reached in 1919 the enormous figure of 13 yen. The imports of platinum in the shape of bars, plates and wires was: 1913, about 390 pounds; 1914, 145 pounds; 1915, 125 pounds; 1916, 280 pounds; 1918, twenty pounds.

Japan's most important ore is no doubt copper. The tonnage production of this metal being in:

1910......................	49,000
1911......................	53,000
1912......................	62,000
1913......................	67,000
1914......................	70,000
1915......................	75,000
1916......................	100,000
1917......................	108,000
1918......................	92,000
1919............(estimated)	80,000

The principal copper firms are Furukawa & Co., Kuhara Mining Co., Fujita Mining Co., K. Sumitomo Mines, Mitsubishi & Co. and Tanaka Mining Co. The profits these firms made during the war were said to have been enormous.

The Japanese exports of copper during the war were as follows:

Countries	1914 *Tons*	1915 *Tons*	1916 *Tons*	1917 *Tons*	1918 *Tons*
China	14,129	1,454	1,514	5,009	7,540
Asiatic Russia	....	30,363	33,809	10,940	141
British India	2,489	1,240	87	4,055	2,475
England	6,922	12,445	14,581	24,933	5,497
France	3,543	4,021	4,242	18,266	8,647
U. S. A.	4,138	7,958	2,967	2,659	38
Germany	2,100	....	....	....	....

The reason for the greatly reduced export figure for the year 1918 and which will still be enhanced for 1919 is chiefly due to the fact that owing to the cessation of hostilities the various countries having piled up large stocks of this useful metal are trying to get rid of them. The mines in Japan were forced therefore to greatly reduce their production.

The zinc industry experienced a tremendous boom during the war, the production in 1918 being about ten times that of 1914. Before the war Japan exported about 30,000 tons a year. There were two big smelteries at the time, viz., the Ohmuta Smeltery of the Mitsui Mining Company, and a smeltery of the Osaka Company in Settsee. Before the war most of the exports were shipped to Hamburg and Antwerp. In 1916, the production of zinc amounted to 53,000 tons and in 1917 to about 80,000 tons.

The output of lead is unimportant and does in no way satisfy the home demands. Before the war it was about 4,000 tons a year and 80 per cent. of this was worked by the Kamioka Zinc Lead Ore Mine of the Mitsui Mining Company. The exports and imports during the war period in tons were as follows:

	Lead Production	*Lead Imports*
1914........	4,600	16,139
1915........	4,800	15,820
1916........	11,490	22,361
1917........	15,800	16,500
1918........	10,700	36,300

The principal providers of lead ore were China, the United States and Siberia; and of lead metal Australia and the United States.

Tin production is quite unimportant; Japan gets her chief supplies from the Straits Settlement.

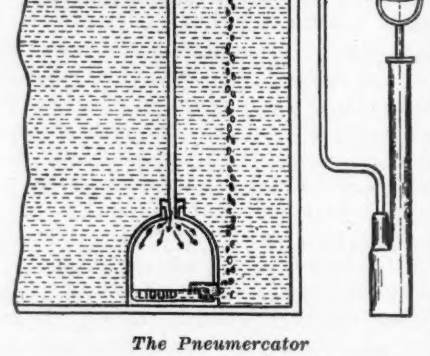
Nickel is not produced at all in Japan, and the total of the country's requirements has to be imported. Whilst before the war England was the principal source of supply, and to a small extent also Germany, the United States has become now one of the chief sellers. French engineers are at this moment in Japan with a view to installing a large plant for the working of nickel.

Aluminum has not been produced yet in Japan, although the important aluminum ores, bauxite and kryolite, are to be found in the country. Up to the war the demand for aluminum was very small, the imports having been about 500 tons a year from Europe and the United States, but during the war, and especially in the last two years, imports were greatly increased.

The production of antimony regulus in Japan rose from thirteen tons in 1913 to more than 10,000 tons in 1916, but the raw ore was chiefly imported from China and worked in Japan. The metal was principally used for the production of amunition; hence the greatly increased demand.

THE PNEUMERCATOR

This device for which the pretentious appellation has been provided, and the essential features of which are shown in the cut we reproduce from *The Engineer*, London, is installed on the *Olympic*, the *Aquitarian* and elsewhere for showing the quantity of oil in the tanks whenever required. There is an air chamber fixed close to, but not upon, the bottom of the tank. This air chamber is open at the bottom with a sharp, level edge all around and the top of it is connected as shown with a hand operated air pump, a mercury pressure gage being conveniently connected with the air pipe. The chamber normally is filled with oil but upon working the air pump the oil is driven down and out of the chamber until bubbles of



The Pneumercator

air escape up through the body of oil. At this moment, since the pressure of the air will rise no higher, the reading of the pressure gage is noted and from this pressure the height of the oil in the tank may be easily computed by the aid of a constant combining the shape of the tank and the specific gravity of the oil.

A three way cock is provided which will permit the release of the air and a reflow of the oil into the chamber and by operating the air pump again another reading is obtained, and so on as frequently as may be desired. With this simple device there is little possibility of error. The temperature of the air makes no difference nor the size or length or sinuosity of the air pipe. The device may of course be used for tanks of any shape or size and for water or any other liquid, the correct constant or multiplier being provided.

Compressed Air in the Cane Sugar Industry

Photograph of the Porto Rican sugar town of Arecibo, on the north coast of the island, showing cane growing beside the Rio Grande. The picture was taken from the top of the new 175-foot smokestack of Central Cambalache, the third largest sugar factory in Porto Rico.

By D. L. THOMSON
Sugar Engineer, Glasgow

COMPRESSED air plays quite an important part in the production of sugar from the sugar cane. A modern factory usually consists of structural steel buildings, covered with galvanized and corrugated steel sheeting, two or more stories high with mills and boiler on the ground floor and steel floors or stagings to carry the different apparatus and tanks in their proper relative positions. In the erection of the factory compressed air is used principally for riveting and caulking operations with pneumatic tools, and occasionally for raising fresh water by air lifts from tubular wells when it stands at a level too low for ordinary displacement pumps.

Of course it is always desirable to locate a factory where an abundant supply of fresh water is obtainable, preferably from an adjacent river, as large quantities of water are required. A factory grinding 1,000 tons of cane per 24 hours, a very common size, will require about 3,000 gallons of water per minute, principally for the condensing apparatus, and if this supply is not constantly obtainable a storage pond must be provided and the same water used over and over again, being cooled by means of a cooling tower or spray pond system. In some cases, if the factory is located near the sea, salt water is used for the condensers but fresh water is always preferred.

Sugar factories usually have a certain amount of private railroad which they operate to bring in the cane supply, but frequently they also depend upon a public railroad for part of same, in which case they may be compelled to equip all their cars with air brakes to allow them to pass over the public lines. So far the uses of compressed air mentioned are such as are common to almost any industrial enterprise and we will now mention some of its applications to the actual manufacture of the sugar. It may be more interesting to the lay reader if we at the same time describe in a general way the whole process of making the sugar.

We will suppose that we have a factory with a capacity for grinding 1,000 tons of cane per 24 hours which is in operation and the railroad cars are therefore dumping the cane into the receiving hoppers at the rate of about 40 tons per hour. Let us now consider its progress through the factory.

From the receiving hopper the cane is carried by an elevator or conveyor to the crusher rollers where it is broken up and roughly crushed to a more or less even blanket which then gravitates by chute to the first mill. The crusher, which consists of two toothed and grooved rollers about 34-in. diameter by 72-in. long, and the first mill, which consists of three rollers of the same dimensions, all mounted in suitable housings and driven through heavy steel gearing by a Corliss engine or electric motor, extract about 65 per cent of the juice, and pass the *bagasse* on to the two or more subsequent mills which with the aid of maceration water sprayed on the blanket of *bagasse* on the intermediate carriers, extract about 95 per cent of the original juice of the cane. This juice contains the sugar, and the *bagasse*, reduced to a moisture content of about 45 per cent and a sugar content of about two per cent, passes from the last mill by means of elevators and carriers to the boiler furnaces, where in a well designed and operated factory it suffices for producing all the necessary steam. For the periodical cleaning of the boiler flues we find compressed air employed to operate rotary tube cleaners. In many cases also the boilers are operated under forced draft which however is not necessary if the smokestack is sufficiently high, say 140 to 150 feet.

Having now disposed of the *bagasse*, as the crushed cane is called, after the juice has been crushed out of it, we will return to the juice, which has been strained by mechanical strainers as it flowed from the mills to receiving tanks. This juice contains about ten per cent sugar and certain impurities which must be eliminated. If a high grade of sugar is desired the first operation is to pump the juice into large circular and deep tanks where it is treated with sulphurous acid gas, produced by burning rock sulphur in special ovens with a limited supply of air usually furnished by a direct acting steam driven air compressor whose speed is regulated to give the exact quantity of air to suit the amount of sulphur burned. Too much air would result in the production of H_2SO_4 instead of H_2SO_3 and the consequent destruction by inversion of sugar in the juice. After sulphuring, the juice is treated with milk of lime to neutralize the sulphurous acid whose bleaching effect has now been accomplished and also to combine with and neutralize the natural acidity of the juice. While the milk of lime is being added to the sulphured juice the contents of the tank are kept in active circulation and agitation by introducing compressed air through a perforated coil in the bottom of the tank to insure a thorough mixing of the lime with the juice. The juice is next pumped through one or more juice heaters and brought, under pressure to a temperature of about 220 degrees F.

The first heater, if there are more than one, is heated by sulphur vapour from the first vessel of the quadruple effect evaporator, or from a pre-evaporator, which will be described later. The effect of heating the juice to this high temperature is to cause the albumen to coagulate and form solid precipitates of the impurities which can be readily separated from the clear juice by decantation or filtration. The juice is decanted in settling tanks and the precipitates and scums are run off to filter presses.

In some cases compressed air is used to operate the filter presses although they are more commonly operated by piston or centrifugal pressure pumps, which are, however, subject to heavy wear and tear on account of the dirty and gritty nature of the liquid handled. When compressed air is used a *monte-jus*, a closed circular tank, replaces the pump; this tank has

a dip pipe reaching nearly to the bottom for the discharge and the compressed air is admitted on the top. The clear filtered juice from the presses is returned to the clear juice in process and the mud now in the form of hard moist cakes is discharged and removed from the factory to be utilized with lime for fertilizing the cane fields.

In some countries, notably Peru, these filter press cakes are appreciated by the labourers who dry them in the sun and use them as fuel to produce smoke for driving away mosquitoes or even for adding to their wood fires for cooking.

We will now return to the clear decanted juice which either passes direct to the multiple effect evaporation, or if plantation white sugar is desired, to the juice filters which consist of cotton bags suspended in jute protecting sheaths in which the juice filters from the inside, leaving the impurities in the form of mud inside the bags, or of cotton or duck covered iron wire frames immersed in closed tanks, in which the juice filters through the cloths to outlet passages in each frame. The impurities remain on the outer surface of the cloths or partly fall and accumulate in the bottom of the tanks. The latter, known as Philippi filters, are probably the most efficient. The clear or filtered juice now passes to the multiple effect evaporator, or previously, in the most modern factories, to the pre-evaporator, where it is boiled with live and exhaust steam and concentrated to a sugar content of about 50 per cent. The pre-evaporator which is heated with live steam furnishes vapour to heat the cold juice in one of the juice heaters previously mentioned, thereby effecting a very great economy in fuel which may amount in some cases to as much as ten per cent of the total steam generated in the boilers, the combination of the pre-evaporator and juice heater forming a double effect.

The evaporator proper is usually a quadruple effect in which an evaporation of approximately four pounds of water is obtained for each pound of steam used in the heating chamber of the first effect. Here again compressed air is used in rotary scrapers to remove accumulations of scale in the evaporator heating tubes. Compressed air is also used in connection with some recent attachments which automatically remove the condensed vapours in the heating chambers and for the maintenance of a constant working level of the juice on the four vessels of the quadruple.

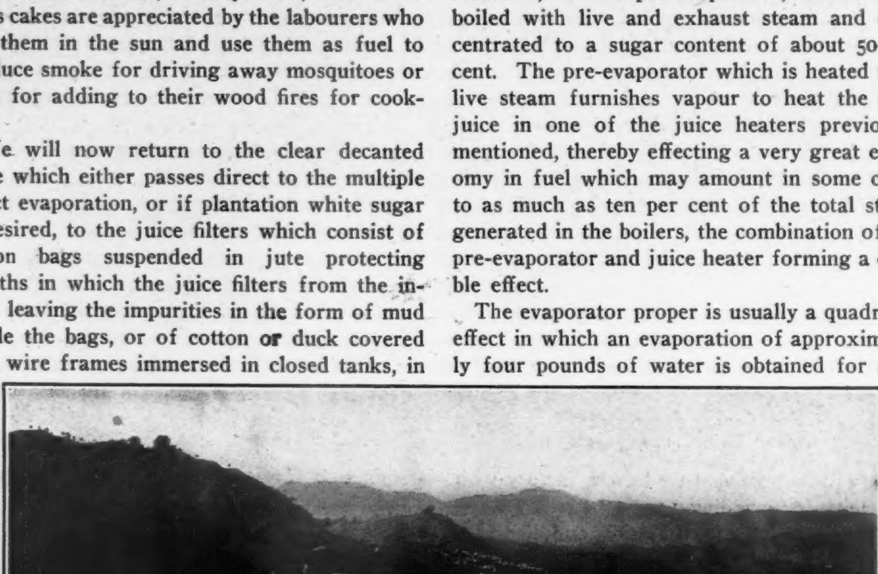
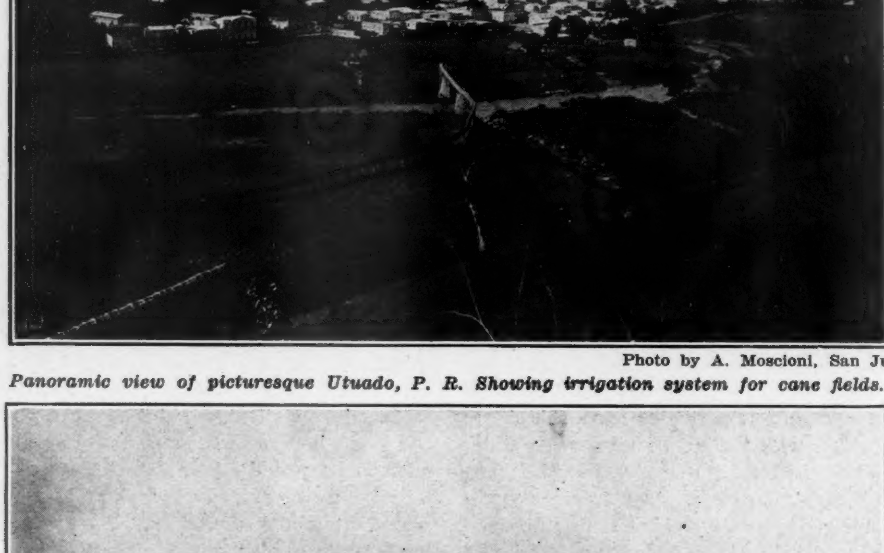


Photo by A. Moscioni, San Juan.

Panoramic view of picturesque Utuado, P. R. Showing irrigation system for cane fields.



American Photo Co., Ponce.

Bird's eye view of Guanica Central, Ensenada, Porto Rico, the second largest cane sugar factory in the world. Compressed air is used to a considerable extent in this great plant, which can grind 5,000 tons of cane per day.

The concentrated juice, now called syrup may again be filtered in filters similar to those described above for the juice, or if only dark crystals are required it is passed directly to the supply tank of the vacuum pans. In the vacuum pans the syrup is boiled down to the crystallizing point and after the sugar crystals are formed successive charges of syrup are drawn in to the pan until the same is full. The contents, now called *massecuite,* is in the form of a magma of crystals and molasses and is discharged by means of gutters or piping to the crystallizers where the mass is kept in slow movement by stirring arms until it is cold. When piping is used to discharge the *massecuite* from the pans to the crytallizers the operation is frequently assisted by admitting compressed air on top of the pan to facilitate the flow of the sticky mass through the piping and valves. In one of the early forms of crystallizers which were made in the form of high vertical cylindrical tanks, compressed air was used instead of stirrers to keep the mass in movement, but this type has been generally abandoned in favour of the horizontal open or closed crystallizer in which the mass is kept in movement by arms attached to a slowly revolving central shaft.

In the closed type of crystallizers, compressed air is used to discharge the cooled mass and to elevate same to the mixers or receiving hoppers of the centrifugals.

The *massecuite* is sometimes discharged from the vacuum pan into a closed cylindrical tank similar to the *monte-jus* above mentioned and elevated by means of compressed air to the crystallizers which may be located on a higher level and in another part of the house. Some factory superintendents prefer to move the *massecuite* in this way rather than to employ a magma pump as they assert that the latter breaks up quite a considerable amount of the sugar crystals.

In the centrifugal the *massecuite,* which now contains 90 per cent or more of crystallized sugar, is spun at a high speed and the molasses separated from the sugar. The sugar, if dark crystals have been produced, is now ready for sacking and shipment to the refineries, but if plantation white sugar has been produced by the use of sulphur and filtration above described, the sugar now passes to a granulator or sugar dryer which consists of a long slightly inclined steel rotating drum through which the sugar is passed and brought intimately in contact with dry and heated air, after which final treatment it is ready for the market.

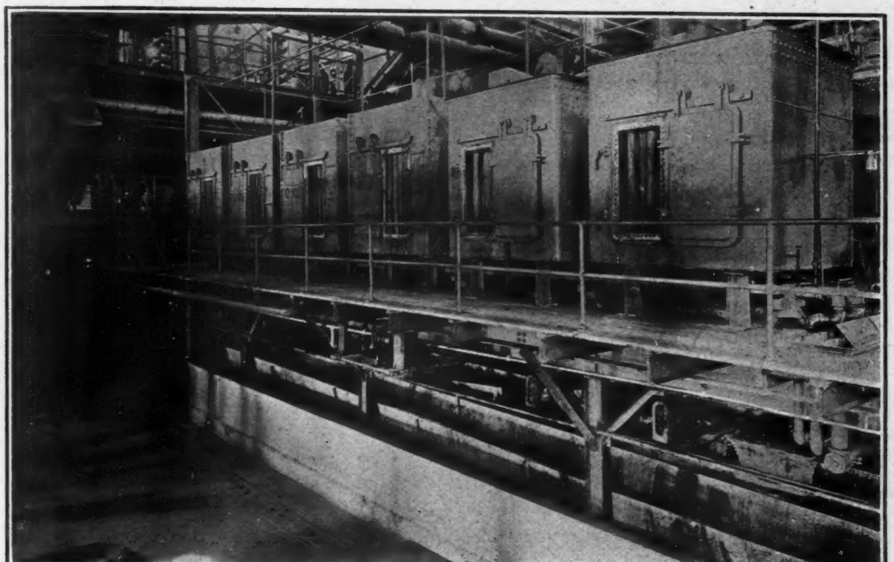
The quadruple effect and vacuum pans above described are connected to condensers which create the required vacuum with the assistance of vacuum pumps which are practically air compressors, taking the air from the condens-

ers under a tension of 26-in. to 28-in. of mercury and compressing it up to the pressure of the atmosphere. With the new and modern types of high speed rotative vacuum pumps fitted with very light and flexible valves and connected to auxillary condensers which cool the air taken from the main condensers, vacuums as high as 30-in. have been obtained in the auxiliary condenser.

For the irrigation of the cane fields some large and successful air lift installations are operating in deep tubular wells where the level of the water is so low that it could not be raised by ordinary displacement pumps.

From the foregoing it will be seen that compressed air plays quite an important part in a modern cane sugar factory.

Initial step in sugar production.



Photos © E. W. Galloway, N. Y.

Double section volute pumps with specially designed open impeller have been developed by the Ingersoll-Rand Co. known as the O D V type for pumping the syrup and have proved to be superior for this kind of work.

CONDENSING INSTALLATION FOR SUGAR MILLS

By R. H. WOMACK

IN DEALING with this subject under the above heading, it is not necessary to pay tribute to antiquity for the knowledge handed down to us, nor to such eminent authors as Torricilli, who, in 1643 produced a vacuum by a falling column of mercury in a tube, and whose name is used to classify the high level condenser. The object of this article is not to go into the theory of producing and maintaining a vacuum nor the function of it, but in order to be clearly understood it is necessary to offer a few suggestions regarding what is now considered a modern condensing plant.

The equipment necessary to make a modern installation is individual barometric condensers for each evaporator and vacuum pan, a central dry vacuum pump and a central water injection pump except where the water supply comes within reach of the condensers.

The condensers should be placed as near the effects which they serve as possible with the view, of course, of maintaining the proper height for barometric condensers. The size of the vapor pipes from the effects to the condensers should be such that the velocity of the vapor will not exceed 250 ft. per second.

The water supply for the condensers should be served from a header or manifold about 15 ft. below the water inlets to the condensers and directly connected to the discharge pipe of the injection pump, thereby completing a closed circuit. This arrangement affords many advantages over the generally accepted plan up until a short time ago of delivering the water into a tank above the condensers and then distributing the water to the condensers from the tank.

With the closed system it is impossible to break priming on the injection pump on account of the temporary shortage of supply water or leaky packing. It is also impossible to break vacuum in the effect when the pump is not delivering normal capacity, which is often the case with electric driven pumps when the voltage is low or with steam driven pumps when the steam pressure is low.

With the closed system the pumping head is reduced about 20 ft. under working conditions with 27-in. vacuum. The plant is much easier to operate, the water easier to distribute to the condensers and the pump easier to prime. This is done by starting the vacuum pump in advance of the water pump. In addition to the above advantages the installation is much cheaper than the tank and broken system.

The vacuum pump should be installed on the ground floor where it can be under the supervision of the engineers operating staff and should be steam driven so as to avoid belt or gear drive and at the same time be able to get the benefit of a variable speed which is often necessary when boiling light or when a part of the house only is in operation. A steam driven pump of modern design is also more economical to operate and to maintain.

The Ingersoll-Rand Type 10 Imperial pump has met with the approval of engineers and operators everywhere on account of its compactness, stability, ease of operation, efficiency, and its reliability.

There was up until a short time ago a prejudice against a central vacuum pump. The argument against was that different temperatures were required in different pans and that during a strike it is often necessary to vary the temperatures in some of the pans. I can give the assurance that there is no condition set forth in this argument that cannot be met with a central pump just so long as that variation in temperature is within the limits of the temperature corresponding to the pressure on the calandria side and to vacuum at the pump. This variation in temperature may be effected by means of adjusting a valve in the air line leading from the condenser to the vacuum pump header. There is another argument sometimes used against a central vacuum pump and that is, that in synchronizing a pan after a strike the vacuum all over the house is disturbed. My observation in this matter is that this happens only when the pump is working to its limit in capacity and this is not the case in the new mills where pumps of ample capacity have been installed. In mills where the pumps are inadequate synchronizing pumps may be installed to bring the vacuum up in a pan after a strike, before it is put in the system.

The latter argument seems to be based on the proposition that it is the vacuum pump which produces the vacuum, but this is not the case. The duty of the pump is to remove the non-condensible gases from the condensers and this is nothing more than an air compressor working below atmospheric pressure. I

am sure that you will agree with me that no one would consider putting in separate compressors for pneumatic tools or rock drills should there be a desire for a slight variation in pressure in order to operate some of the tools, as this variation is under the operator's control when a valve is placed in the air line serving that tool, and this corresponds exactly to the vacuum pump when a variation in temperature is required in the pans.

The water injection pump should be a centrifugal and installed as near the source of supply as possible. This pump should be mounted on a common base with, and directly connected through a flexible coupling, to either an electric motor or a steam turbine; preferably the latter. for the reason that it is sometimes necessary to get a little variation in speed on account of a falling off of efficiency of the pump or a variation in the temperature of water. Local conditions though, often dictate and do not permit of a preference in drive.

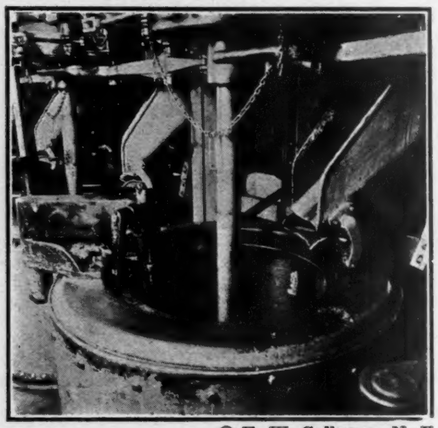
This pump occupies one of the most responsible positions in a boiling house for the reason that in case of failure it not only effects a shut down of the mill but it is somewhat retroactive inasmuch as the work which has already been done in the pan may have to be done over again.

The A. S. Cameron Steam Pump Works have taken this into consideration and are offering pumps for this service where every element of chance has been eliminated so far as it is possible to do so within the limits of design, workmanship and material, and in these units price should not be considered.

This interesting piece of apparatus has, up until recently, had but little attention paid it. It has been looked upon as a mixing pot only for water and vapor while one of the most important duties which a condenser has to perform is that of separating the non-condensible gases from the other elements. If these gases are allowed to congest in eddies or to take high velocities through restricted areas the distribution of water becomes so erratic that it is impossible to reckon with efficiency.

The Ingersoll-Rand Company recently developed a condenser wherein this feature has been given special attention, and they are getting excellent results. They guarantee to operate on a terminal difference of five degrees between exhaust steam and hot well. It is impossible to approach this terminal difference with the old-fashioned raintype and parallel flow type of condensers which have been extensively used in the past, and experience indicates that 15° to 20° difference in temperature is the best performance to be expected, since in the parallel flow type it is necessary to use an excessive quantity of injection water in order to cool down the non-condensible gases to a temperature that will permit economical handling by the vacuum pump.

The Ingersoll-Rand condensers are provided with a reservoir on the inside, into which the water enters and the air which is entrained in the water is removed before it comes in contact with the steam, thereby reducing the volume to a minimum and at the same time preventing high velocities of non-condensible



© E. W. Galloway, N. Y.

A close up photo of a sugar centrifugal machine in Godchaux refinery at Reserve, La.

gases in the condenser. The water from the reservoir runs over a weir in a sheet sufficiently rigid so that it cannot be blown aside by incoming vapor. With the spray, or rain type condenser, the water is admitted under low pressure and meanders down through grate bars and these sprays are so light that they are readily blown aside by incoming vapors, and it is very evident in this case that the vapor takes one side of the condenser and the water the other. This is evidenced by the different temperatures of the condenser, and unless there is a tremendous excess of water this results in low vacuum and large volumes of hot gases passing over into the vacuum pump.

It seems that a few years ago there was quite a tendency to install central condensers into which the non-condensible gases from the individual condensers were passed and there recooled. This system, however, is entirely without merit for the reason that it becomes necessary to install valves in the vapor lines or on the inside of the condensers which are very large and slow to manoeuvre and very often impossible to close entirely. Furthermore a central condenser into which all the non-condensible gases must pass is necessarily a very large one. In fact the non-condensible gas areas in this condenser should be equal to the combined non-condensible gas areas in the rest of the condensers, and in large condensers it is almost impossible to make a uniform distribution of small quantities of water, and as the amount of work to be done in this connection is small, a large volume is wasted. This condenser is therefore expensive and inefficient and should not be used.

I have been asked by some of the engineers for information with regard to the volumetric contents of condensers and vacuum pumps in terms of tons of cane per hour. I appreciate that in standard mill work the volume of steam per hour to be condensed may be approximately ascertained when the tonnage and masceration of the mill are given, and that the size and volume of all mill pumps, prime movers and boiling house apparatus may be determined from this, but we are not able even to state approximately the size of the apparatus required to condense a given amount of vapor unless the temperature of injection water and the vacuum required are given. In sugar house work the head against which the water must be pumped largely determines the vacuum. That is, of course, within reasonable limits, say between 25-in. and 28-in. Uniform as conditions seem to be in the Hawaiian Islands, the volumetric contents of condensers and vacuum pumps will vary as much as 100%. It is therefore a case where each mill is a problem within itself.

The Ingersoll-Rand Company's condensers are rated in gallons of water per minute which they will handle with due consideration being given to the non-condensible gases, and, of course, the vacuum pumps are rated in the usual way of piston displacement with corrections for volumetric efficiency.

AIR COMPRESSORS IN A CUBAN SUGAR FACTORY

A CORRESPONDENT of *The Louisiana Sugar Planter* gives us an interesting account of a visit to a Cuban sugar factory. Several years ago, he writes, Central Rosario, was characterized by Prof. J. T. Cawley, former director of the Cuban Experimental Station, as the finest sugar estate on the island in proportion to its size and the returns it brought its owners, the Rosario Sugar Company.

The factory would seem to be a model installation not only in its equipment but also in its upkeep. It always looks as if freshly painted and in the pink of condition, in marked contrast to many of its neighbors.

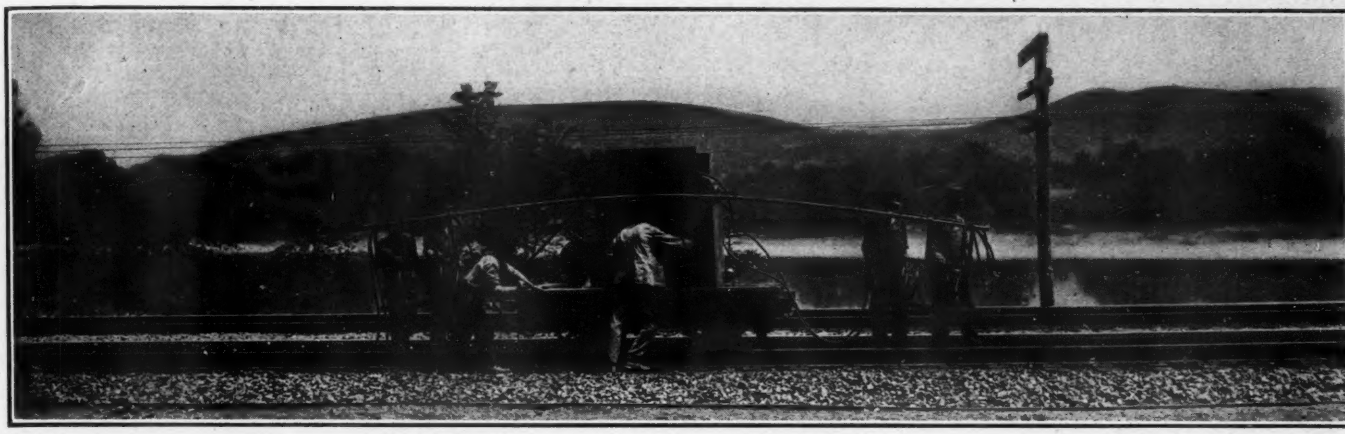
The factory is steam driven, the motive power being generated in Babcock & Wilcox boilers set two to a furnace. Most of the machinery seems to be of French or Belgian manufacture, with an occasional German pump. Besides the American Tool & Machine Co.'s contrifugals, the Babcock & Wilcox boilers and the Wheeler Condenser & Engineering Co. apparatus, the only other American machinery noticed were two Ingersoll-Rand air compressors and Fairbanks sugar scales.

ODORS OF VARIOUS OILS

The odor of petroleum is generally believed to be due to sulphur compounds. Sometimes small proportions of hydrogen sulphide gas is noted in certain crude oils. This gas has the peculiar nauseating rotten egg odor familiar to all laboratory workers. It is also quite toxic. Some nitrogen compounds also have rather strong odors. As a rule the odor of nitrogen compounds is not as unpleasant as that of sulphur bodies. Numbers of the hydrocarbons of both the aromatic and aliphatic series, particularly the lighter more volatile members, have characteristic odors which are more or less noticeable. For example, benzol and pentane have their characteristic faint pleasant odors. Pure refined lubricating oils nearly all have faint "oily" odors which are not unpleasant.

The closing of the Dolcoath mine in Cornwall puts at any rate a temporary end to a continuous period of activity reputed to be almost the longest anywhere in the world. The majority of the workers have now been paid off, and it is feared that other mines in this area may have to close.

Air Reduces Railway Maintenance Drudgery



Ready to move the car one rail length by hand.

IN RELAYING RAILS one of the problems which it has been most difficult to overcome has been that of keeping the men steadily at work. The task of the tong men in removing the old rail and placing the new has always been extremely laborious, while that of the drillers preparing the bond holes is both fatiguing and monotonous. It has not been uncommon to have men leave the work at different times throughout the day because of its character. With an abundant labor supply as in the days before the war this was not such a serious difficulty as at the present time.

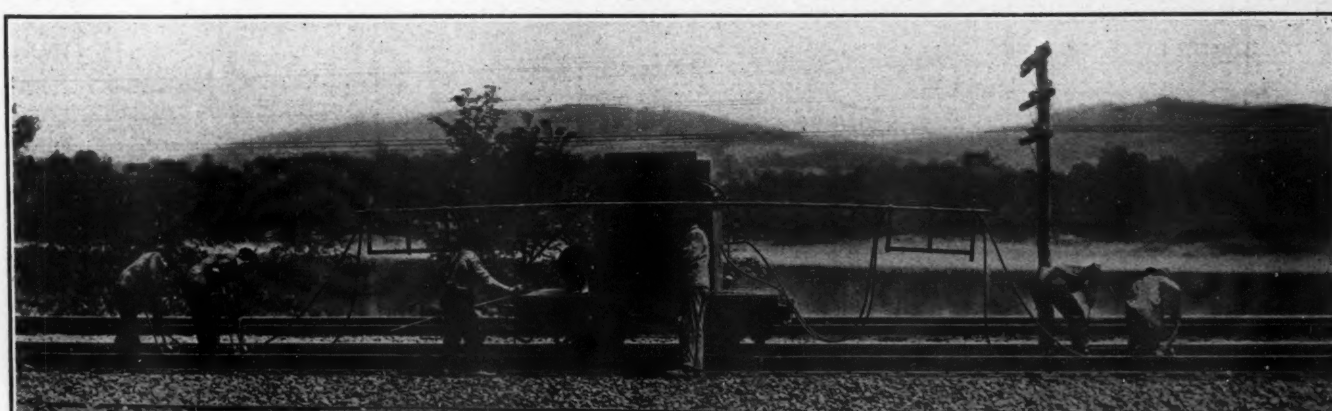
In an endeavor to reduce the drudgery to a minimum the Lehigh Valley developed a plan some time ago of relaying rail by using locomotive cranes. This was described on page 178 of the May, 1918, issue of the *Railway Maintenance Engineer*. The use of this method has resulted in speeding up the work with less hardship to the trackmen. Since the adoption of the locomotive crane for laying rail the main drawback to this work has been the bonding. The difficulties attendant on this work have now been overcome by the use of the machine shown in the illustration. With it the men have done better work, a less number have been used, there has been no necessity of relieving men on account of the laborious character of the work and the bonding has been completed within a few minutes of the rail laying.

Two arrangements have been developed, one on the Wyoming division and the other on the Seneca division, which are similar in their general plan but which differ in their methods of operation. In general they consist of an air tamping machine to which four pneumatic drilling or bonding machines are attached by lengths of pipe and air hose. In one case the machine was moved by hand and in the other two motor cars were used.

The smaller outfit was built up by fastening a 21-ft. length of one and one-fourth inch pipe to the side of the air compressor and parallel to the track in such a way that it cleared the top of the rail by about five and one-half or six feet. A reinforced U-shaped bracket with hooks made from scrap iron was fastened to each end of this pipe as a support for the air hose, upon which the air drills could be hung when not in use, or when moving from one location to another. A two-way connection was attached to the outlet pipe of the tamper to which there was attached a second two-way connection and a short length of air hose. This section of air hose was carried over the top of the tamper and a third two-way connection made fast to it. A 25-ft. length of hose and an air drilling machine was then connected with each of the four outlets so formed. This gave two machines on each side of the air compressors, each machine drilling one side of a joint and the four machines drilling the bond holes for two rail joints at one time. In handling the machine the one and one-fourth inch pipe proved to be a little small, as it bent considerably when the four air drills and hose were hung on the brackets, and it will therefore be changed in future installations to a two inch pipe made slightly longer, but not to exceed 25 ft. in length.

As will be noted in the photographs, six men are used with this outfit, four men operating the air drills, one the air compressor and one to push the entire outfit. Where the gang is working up grade or where it is desired to cover the ground at a little faster pace one man may be added to help push the machine.

The second arrangement consisted of an air compressor of a similar nature and two motor cars. These three units were connected together with the compressor in the center by means of two 20-ft. lengths of two inch pipe, flattened at the ends in order to bolt them to the cars and to the compressor. Four drilling machines were used as in the preceding case, arranged so that there was but one machine to a joint. The air was supplied by means of about 80 ft. of three-fourths inch pipe mounted above the air compressor and supported at each motor car by two uprights fastened to the framework of the cars, and by two five feet two inch uprights clamped to the



Bonding 100 rail joints per hour

A motor car is used to move the machines.

two inch pipe connections at a point on each side of the air compressor. Connections were made with the air drilling machine to short lengths of hose, the two center lines being approximately eight or ten feet long and the end ones about fifteen feet.

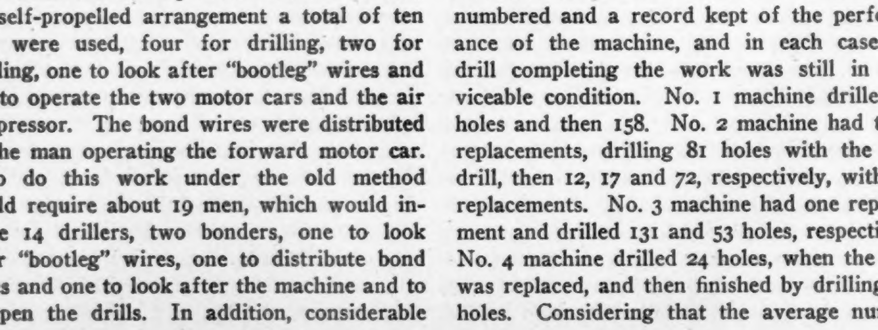
With the completion of the drilling at each of the four joints, the air drills are suspended on hooks provided for that purpose and the outfit moved ahead under its own power. In this case the men do little or no walking and the movement from one set-up to another is accomplished in about 20 seconds. The motor cars are utilized to carry such additional equipment as is necessary, such as extra drilling machines, air lines, drills, bonding wire, etc.

The results obtained by the two outfits show that the number of men usually required for the work was considerably reduced, the bonding kept up with the rail laying and the men were kept interested in their work. As stated before, six, or in some cases, seven, men were used with the hand-pushed machine. With the self-propelled arrangement a total of ten men were used, four for drilling, two for bonding, one to look after "bootleg" wires and one to operate the two motor cars and the air compressor. The bond wires were distributed by the man operating the forward motor car.

To do this work under the old method would require about 19 men, which would include 14 drillers, two bonders, one to look after "bootleg" wires, one to distribute bond wires and one to look after the machine and to sharpen the drills. In addition, considerable more time would be spent at this work under the old way, as this number of men would be required to work about two hours after rail laying was completed in order to finish the bonding.

A total of 730 holes of three-eighths inch diameter were drilled by the smaller unit in three hours, 36 minutes, and a total of 1,672 by the larger unit in a working time of seven hours and 30 minutes. In both cases the results were not indicative of the amount of work which could be done with these outfits in a given time, as both were delayed considerably by the rail layers.

At one point, 354 lengths of 136-lb. rail were unloaded, laid and the old 100-lb. rail picked up in a total elasped time of six hours, the bonding being completed sixteen minutes after the track was connected. The drill replacement record in this case was exceptional, for only six drills were replaced in drilling 730 holes at the rate of 203 holes per hour. Furthermore, two of the six drills were broken accidentally. Each of the four drills was numbered and a record kept of the performance of the machine, and in each case the drill completing the work was still in serviceable condition. No. 1 machine drilled 26 holes and then 158. No. 2 machine had three replacements, drilling 81 holes with the first drill, then 12, 17 and 72, respectively, with the replacements. No. 3 machine had one replacement and drilled 131 and 53 holes, respectively. No. 4 machine drilled 24 holes, when the drill was replaced, and then finished by drilling 156 holes. Considering that the average number of holes per drill which has been secured heretofore by the hand method is about 14, there was a saving in this case of 46 drills, which at present prices would amount to $40 or $45 in less than one day's work.



A three-unit arrangement in operation.

COST OF LEAKY AIR BRAKE HOSE TO THE RAILROADS

When trains are pumped up before departure, says a *Railway Age* editorial, the inspector makes a cursory examination to detect audible leaks, but leaks in porous hose can seldom be heard and usually are not found. The extent of the loss from this cause is shown by the fact that in a series of tests of trains of 65 cars, by removing from five to eight porous hose, the rate of leakage in the train line, which had ranged from 12 to 20 lb. per minute, was reduced to 6 to 8 lb. per minute. Excessive leakage is both costly and troublesome. The amount of steam used by the air compressors may amount to as much as 10 per cent of that used by the locomotive cylinders, and if this can be cut in half, as in the cases cited above, a direct saving of 5 per cent in fuel will result. Many terminal delays are caused by inability to get the required train line pressure, due solely to porous hose, and on the road the leakage causes difficulty in handling trains. The remedy for this condition is not difficult of application nor expensive. In the first place, the uncoupling of cars without first parting the hose by hand must be stopped, as this is the principal cause of porous hose. It is not enough to issue instructions to all concerned. Some employee must be delegated to part the hose on all incoming trains. To make sure that hose are not allowed to remain in service after they have become porous, periodical tests must be made by painting the hose with soap suds. The saving through the elimination of leakage was estimated in 1918 to be at least $35 per car per year. Under present conditions, it would certainly be much greater.

BLASTING WITH QUICKLIME

The National Lime Association describes as follows a very simple, safe and cheap method of wrecking and shattering rocks, foundations, etc., by utilizing the tremendous expansion force developed by slaking quicklime.

To break up an old stone wall or other masonry, or to knock out a superflous brick pier without the use of dynamite, slow hand labor is unnecessary. Simply drill a good-sized hole in the wall—making this bottle shaped with as small an opening as possible. Put in quicklime until this hole is almost full and make a tight-fitting wooden plug that can be driven firmly into the opening. Quickly pour in enough water to slake the lime and drive home the plug. The expansion of the lime as it slakes will exert a tremendous pressure that will easily break up any ordinary piece of masonry.

In Prague a company with a capital of 2,000,000 kronen has been floated under the name of Associated Carpet Manufacturing Company.

Air Aiding the Revival of Germany's Industries

Compressors and Special Tools Helping to Transform the Great Krupp Works from a War to a Peace Basis—Compressed Air Invading New Fields because of Labor Costs and Lack of Man Power

By CHARLES A. BRATTER

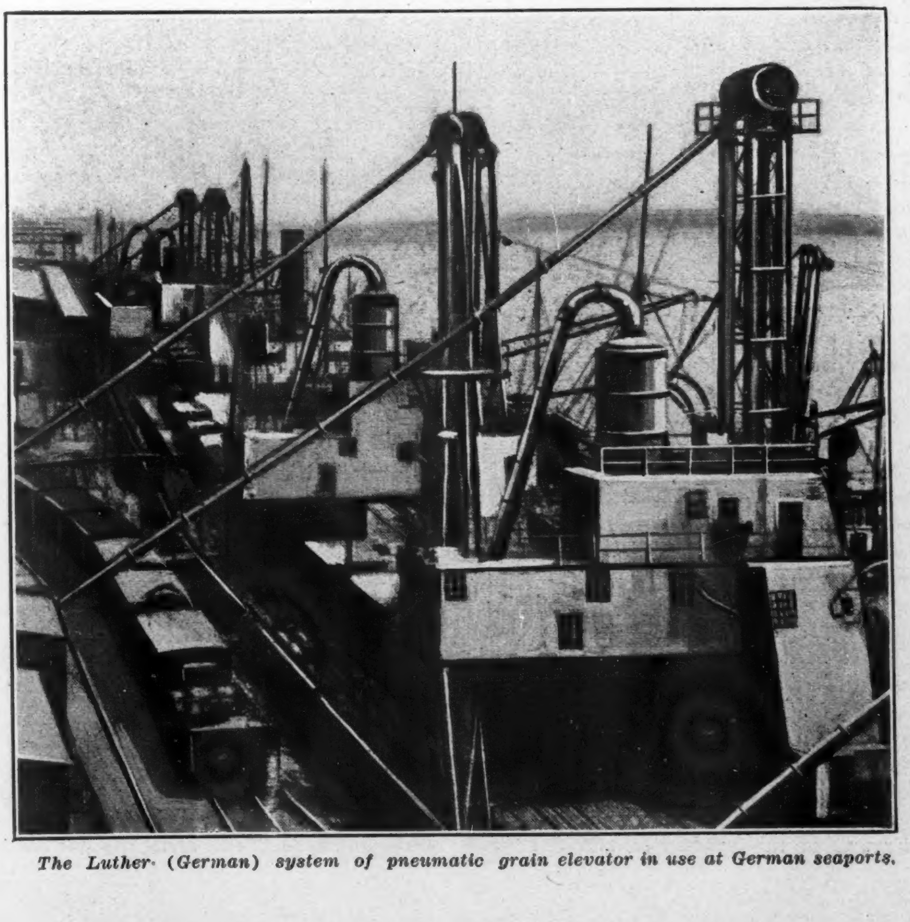
FOR THE SECOND time since the outbreak of the war, a mighty transformation is taking place in Germany's industry. Then many factories which had been producing solely articles for peaceful use were made to serve the ends of the murderous conflict; today exactly the contrary is taking place. Krupp, Germany's great gunsmith, is no longer thinking of armorplate and cannon. The mighty hammers still thunder through the great halls at Essen, powerful presses still work on the glowing iron, but it is locomotives—one every day—freight-cars, and agricultural machines that are being turned out. The mammoth concern has also taken up the smaller things of fine mechanics. Photographic cameras and typewriters are being manufactured, and even calculating machines are soon to be added.

The chief engineer of the Krupp Works informs me that in the course of the transformation of this great concern from war to peacetime productivity, compressed air is being used extensively, especially as motive power for apparatus, and for tools of the most diverse sort, such as are used for example, in moulding houses, foundries, boiler works, and the sheet metal departments. Stamping machines, chisels, drills and riveters are operated by air, and of course in the mining branch compressed air is used to drive winches, hoists and drills.

A similar transformation is seen in another concern, the Rheinische Metallwaren und Maschinenfabrik (Rhenish Metal Ware & Machine Works) in Düsseldorf, whose tubular-recoil guns were once noted throughout the world. This concern, too, has taken up the manufacture of locomotives. Even more striking is the change in the aeroplane factories, which naturally flourished greatly during the war. Some of them have gone over to the making of furniture, others are turning out agricultural machines and still others are manufacturing motorboats.

All these things, however, are but outward manifestations of a thorough transformation and reshaping of the German industry. The conditions of the Peace of Versailles as explained in a preceding article, affect materially the country's coal and iron industries. Alsace and Lorraine, with their ores and potash, are in the hands of the French. The Sarre with its coal basin and parts of the Palatinate are subject to French control for fifteen years. In addition to all this, Luxembourg has been removed from German influence and must seek economic connections with France and Belgium, and Luxembourg, through the Customs Union, was formerly in effect an economic part of Germany, and its ores were indispensable to the German coal and iron industries, which were steadily increasing there. These supplies of ore, the foundation of the parent industries, are even now being diverted from them, and no others have been found to take their place. Despite the most intense and intelligent efforts, it is unlikely that any substitutes will be found in the near future.

The statistics speak eloquently. In the last peace-year (1913), Germany's iron mines—some 330 in all—produced 28,600,000 tons of crude ore, with a value of 115,750,000 marks. If one adds the production of Luxembourg, about 7,000,000 tons, it makes a total of about 35,500,000 tons produced in the German customs district. The production of these districts showed a rapid increase, jumping from 11,400,000 tons in 1890, worth 47,800,000 marks, to 28,700,000 tons in 1910, with a value of 106,800,000 marks. In addition to Germany's production of iron-ore, 80 per cent. of which (by bulk) came from Lorraine and Luxembourg, there was a considerable import before the war of foreign ore, in part very high-grade ore. Germany's total imports of iron ore in the last peace year amounted to 14,020,000 tons, with a value of 227,000,000 marks. Exports amounted to 2,610,000 tons, with a value of 7,700,000 marks, of which about a third went to France and two-thirds to Belgium. For the future Germany will be more than ever dependent upon imports from abroad for her iron ore requirements, for Lorraine and Luxembourg, and in a sense of the word the Sarre basin as well, must now be regarded by Germany as foreign countries. Lorraine's supplies of iron ore have been reckoned at 1,800,000,000 tons, Luxembourg's at more than 3,000,000,000 tons. The mines that remain in Germany's possession, however, such as those in the valleys of the Sieg, Dill and Lahn, in the Harz and Upper Silesia, while they contain ore of a good grade, will be exhausted within a period already calculable, and especially if their exploitation be now intensified. In the Siegerländer-Wieder Spat district, 2,730,000 tons were mined in the last peace year, in the Nassau-Upper Hessian district,—the Lahn and Dill district—1,100,000 tons, and in the so-called Super-Heroynian district in Hannover—Peine- Salzgitter—921,000 tons. The ore production in



The Luther (German) system of pneumatic grain elevator in use at German seaports.

Upper Silesia has been decreasing steadily, having dropped from 485,000 tons in 1901 to 142,000 in 1919. Prospecting after new iron ore beds in Germany is now being carried on with energy and improved technic does not reject even the poorest ores, but it is doubtful whether any new, exploitable fields will be discovered, at least in the near future.

The well-known German chemist Fritz Haber, who received the Nobel prize for his discovery of a method of extracting ammoniac from the air, has recently pointed out that the epoch of the heavy metals is nearing its end. This is probably true as to all Europe, but especially for Germany, and substitutes must be found. During the war, German scientists began an intensive hunt for substitute metals. In the place of copper, almost all of which had to be imported from abroad, tin and even, in certain cases, iron were used. Many new uses were found for aluminum. This metal, which can be produced from the cheap argillaceous earth which occurs everywhere, is to be produced in vast quantities in Germany by using electricity. But the epoch of the light metals, which, according to Haber, are destined to replace the heavy metals, will not come without the conquering of many infantile diseases. The German industry has already realized that some method must be found to compensate for the increasing dearness of the raw materials which form the basis of production. The only way of doing this is to improve processes in every way possible and to use every bit of material to the last particle. And this is being done to-day in the most diverse branches of the metal industry.

It is in the treatment of coal, however, that one can observe this development at its best. Germany can no longer permit itself the luxury of a reckless use of coal, the only wealth which it still has. Efforts to utilize all the components of coal are being directed toward two ends—the utilization of its entire heating value and of all its chemical properties. It is pointed out that an extraordinary amount of valuable caloric energy is simply lost in the air in our coking ovens. The heat units thus lost in Germany in the course of a year are equivalent to the heating power of a half million tons of the best anthracite. The waste connected with byproducts is still greater. As everyone knows, these byproducts—tar, benzol, ammoniac, sulphur—furnish a considerable part of the profits of the coking ovens, which, by virtue of producing these things, become a factor in the chemical industry. But the production, no matter how scientifically it is carried on, is still short of that degree of perfection which is desirable. Attempts have been made to resolve tar, at the very moment of its thickening, into diverse components with a high boiling point, but the process has not yet been perfected technically. As to benzol, it is but a short time since the manner and cause of its origin were cleared up. The binding of ammoniac at the coking ovens is carried out with sulphuric acid. The resulting sulphate of ammonia is used as a fertilizer. How uneconomic and wasteful this process is is apparent from the fact that every four kilograms of this product contain three kilograms of sulphuric acid, which has no value as a fertilizer and also represents useless ballast on which freight must be paid. Germany, furthermore, has to buy millions of marks' worth of sulphur abroad every year.

The artificial gas industry, which came into existence at the end of the eighteenth century, had a long struggle against tar, which was regarded as an annoying byproduct, hampering the manufacture of gas, until, around the middle of the last century, practical chemistry took up the problem of this Cinderella and made tar one of the most highly prized raw products. Germany stands again to-day at the very beginning of a new chapter in the history of the treatment of coal. Despite the unfavorable conditions, two new institutes for coal investgiation have been organized alongside the one already existing at Mülheim—one in Westphalia and one in Breslau. Special institutes for the investigation of lignite, the so-called brown coal, have been opened in Berlin and in the old Academy of Mines in Freiberg. The German scientists' work is being directed not merely to the utilization in the chemical industry of the byproducts of coal, but also, and even in higher degree, to utilize as raw materials for chemical ends every single property of coal, and not merely the byproducts. A beginning along these lines had already been made in the lignite industry. The chief byproduct here is lignite tar, from which paraffin, the basis of the candle-making industry, is procured. In addition to this, the brown coal furnishes benzine, illuminating oil, gas oil, tar oil and lubricating oil. The newest investigations in this territory have already practically solved the problem of the complete metamorphosing of fuel into chemical products. This is done by employing hydrogen, and the process leaves only ash and oils. All the rest becomes utilizable chemicals. The metamorphosis is brought about by the employment of compressed air and water. This means that coal has become an important chemical raw material in itself, and that the chemist may hope that it will in the future be possible to extract from this source all the fundamental elements of organic chemistry. And thus, now as in the old days, German chemical industry is working hand-in-hand with science.

But it is not merely toward the highest possible utilization of all raw products that German industry is striving; it is also trying to find better working methods in the factories, but methods which shall at the same time the best conserve man-power. This is being sought through standardization and also through the application to German conditions of the Taylor system. A striking illustration of these endeavors is found in the employment of compressed air, which is constantly invading new fields because of the increasing cost of labor. The pneumatic postal tubes have been taken as a model in industries where goods have to be transported. A compressed air system was but recently established in a coal mine. It carries 50 to 60 tons of small coal over a stretch of 100 meters every hour. The principle is the same as that employed in the loading and unloading of grainships with pneumatic elevators. The success of experiments along this line has been such that they are to be extended. The use of compressed air in the laying of foundations under water is also increasing in Germany. Compressed air tools of every description—hammers, drills, even locomotives—are to-day much more extensively used than before the war. It has been realized that man power alone will not be able to cope with the tremendous task of rebuilding and renewing. Here is where compressed air, because of the many ways in which it can be employed, gives promise of making possible the greatest amount of useful work.

All this gives but the barest outline of the manner in which German industry is trying to adapt itself to the new conditions. Much that really belongs even to such an outline has had to be omitted because of lack of space. One thing more may, however, be mentioned. The leaders have a clear aim; it is their definite purpose to make German industry once more one of the leading industries in the world market. In alliance with scientific technicians, with theorists and practical sociologists, the various problems have been taken up boldly. It is possible that the old mistake of over organization has been made in some instances. But even if not all the plans materialize, Germany, even though it be difficult to obtain the raw materials which once were so plentiful, will come to the front again if her laboring men and women, who admittedly possessed a high degree of intelligence and education before the war, will but take communion with themselves and realize that only through labor can the almost unbearable conditions of the present be cured.

A NOVELTY IN CHIMNEYS

What is said to be easily the tallest chimney in the world is in Wales. It is more than two miles long, and besides that it has a brook running most of the length of it. The chimney was built by a smelting company after the neighbors for miles around had threatened that unless something was done to divert the drift of copper smoke which destroyed vegetation and even rotted the hoofs of farm animals, they would take the plant away, brick by brick. A famous engineer was called in, and began a chimney which extended from the roof of the plant up a mountainside back of the works. The chimney, in addition to crawling the two miles up the mountain, extends 100 feet in the air. The brook flows almost the entire length of the chimney on the ground, as it was found that the running water would condense the smoke to a great extent. Once a year the chimney is swept, and a ton of precipitated copper is reclaimed.

How the bee worker may be aided by the metallurgist is reported from New Zealand by Mr. G. V. Westbrooke. Thin sheets of aluminum, shaped into worker cells, were coated with beeswax, and the bees accepted this substitute for their own work, promptly building on the coated edges. Not only has the bee saved time, but the metal combs could be extracted without breakage, even when containing thick honey, and high extractor speeds were employed.

ANACONDA ISSUES A NEW COPPER TREATISE

THE ANACONDA Copper Mining Company, of which the United Metals Selling Company are the sales agents at New York, has issued another highly attractive booklet, beautifully printed and illustrated on fine paper, entitled *Copper from Mine to Finished Product*. This brochure of 58 pages gives in brief a description of the great organization's activities, including a prefatory chapter on the development of the company. The Anaconda Reduction Works is described in a section devoted to smelting and an outline of processes, following which comes a dissertation on the electrolytic refining of copper at the Raritan Copper Works. A discussion of the rolling of copper into wire at the Great Falls (Montana) reduction department of the company is followed by an highly interesting article on the electrolytic zinc plant, also at Great Falls. The last two sections of the brochure take up the refining of lead bullion and the production of white lead. Few pieces of modern engineering and commercial literature that have come to our attention in recent years can compare in interest with this treatise, and it is as well edited, written and printed as it is interesting.

LARGEST STEAM DRIVEN HOIST AT QUINCY MINE

THE MICHIGAN Copper Country, already the initiator of many advances in the field of mining has now hung up another trophy in the annals of mechanical engineering and has recently put into operation the largest steam-driven hoist in the world. This new installation, which has been designed and manufactured by the Nordberg Manufacturing Co. of Milwaukee, Wis., has been effected at the No. 2 shaft of the Quincy Mining Co. at Hancock, Mich., and the building in which it is housed occupies a prominent place on the north side of Portage Lake.

The hoist, which is duplex, cross-compound, condensing and operates in balance, is designed to raise a load of ten tons of rock at a maximum rope speed of 3,200 ft. per minute. A cylindro-conical type drum, having a maximum diameter of 30 ft. and a minimum diameter of 16 ft., is supported by two main bearings, 28-in. in diameter by 54-in. long, upon triangular castings which rest on concrete foundations and also support four engine frames and cylinders. The winding capacity of the drum is 10,000 ft. of 1⅝-in. rope and this attains a vertical depth in the inclined shaft of 6,600 ft., although a total rope capacity of 13,300 ft., or 8,600 ft. vertically, can be secured by winding the rope down on the opposite cone.

Each of the four engines of the hoist is set at an angle of 45 degrees, two high-pressure and two low-pressure cylinders on each side being attached to the cranks of the drum. Both engines on a side are attached to a common crank pin, 15-in. x 15½-in. in diameter. High pressure cylinders are 32-in. in diameter, low-pressure, 60 in., and stroke is 66 in. The low-pressure pistons are supported by cross-head and tail guides. High-pressure piston rods are six inches and low-pressure, ten inches in diameter. Cross-head pins are 8x12-in. Between each high-pressure and low-pressure cylinder a reheating receiver is placed, the pressure within which is under the control of the operator.

The condensing equipment is capable of handling 1,460 ft. of steam for each trip of 10,000 ft. The low-pressure cylinders exhaust into a 8-ft. diameter x 17 ft. steam drum, from which the exhaust steam passes to the air pumps.

The drum, which weighs 516,000 lb., is constructed in 48 sections, bolted together, and provided with inner trussing which prevents any deflection. To each end of the drum are attached post brakes of an improved type, sixteen feet in diameter. Each pair of brake shoes is operated by an oil cylinder and these are controlled by special poppet valves, one controlling the lift and the other the drop of the piston, being so arranged that both valves can be operated simultaneously.

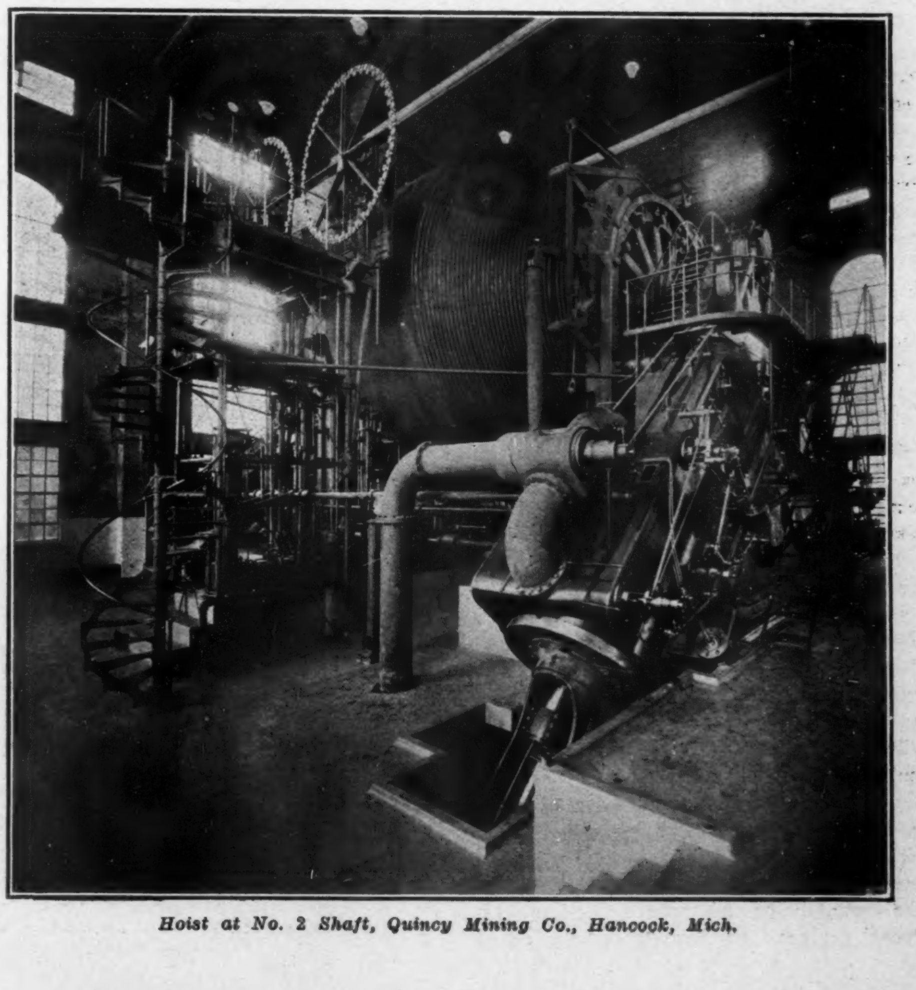
The operator by means of a floating lever gear controls all of the mechanism. The throttle can be automatically closed, as the skip approaches the landing, by means of an improved safety stop; overwinding applies the brakes automatically, and the control is so arranged as to prevent the hoist starting in the wrong direction, and overspeeding is prevented by means of a speed governor controlling the cut-off cams of the valve gear.

Together with the condensing equipment the hoist weighs 1,765,000 lb., occupies a floor space of 60 ft. x 54 ft. and has a vertical height from the foundation to the top of the drum of 60 ft. The weight of 10,000 ft. of 1⅝-in. rope is 41,500 ft.; weight of skip, 10,000 lb., and the time required for one trip of 10,000 ft. is 4 min. 8 sec.

AN ELABORATE NEW COAL MINING LABORATORY

The most elaborate coal-mining laboratory in America is just being completed for the Carnegie Institute of Technology, of Pittsburgh. The equipment comprises a full-sized coal mine, except that it yields no coal; a mine locomotive and a full set of coal- and metal-mine machinery that have been furnished by manufacturers. The laboratory is located beneath the building of the division of science and engineering of the institute. In connection with the mining laboratories there will be a well-equipped ore-dressing and coal-washing plant. It is proposed to extend the mine during the practice work of the students along such a plan that it can be utilized for carrying some of the steam and water pipes of the institute.

It is reported that the Roumanian Traffic Ministry is negotiating with German firms for the purchase of tank cars to be used in the extension of oil export. There is to be immediate delivery of from 2,000 to 3,000 tank cars of fifteen-ton capacity, at a price of 85,000 lei each.



Hoist at No. 2 Shaft, Quincy Mining Co., Hancock, Mich.

Air in Shipbuilding on the Clyde

Modern Pneumatic Installation of Harland & Wolff at Govan—Uses of Air in the Latest and Largest Motor Ships

By ROLAND H. BRIGGS

"MAKE FULL use of compressed air. Do everything you can by pneumatic methods." This is evidently the opinion of Messrs. Harland & Wolff & Co., Ltd., with regard to the place of compressed air in the shipyard. Probably no shipyard in the world is better organized or in a higher state of mechanical efficiency than the Harland & Wolff yards and shops at Govan-on-the-Clyde, so that a testimonial from such a source shows how unassailable is the position of compressed air for shipbuilding purposes.

The compressed air power station of the company is a fine one, and the Ingersoll-Rand and Bellis & Morcon compressors which compose the compressed air generating plant have a combined capacity of 10,000 cubic feet of free air per minute compresssed to a pressure of 100 pounds, but extensions of the power house and plant are under contemplation. In addition to the air compressors, the hydraulic accumulator and cooling plant are situated in this building.

A ten-inch underground air main runs throughout the yard, with branches down every slipway and to each of the great workshops. The slipways are separated by long stone piers, and access is obtained from above into the interior of these piers by means of manholes and iron ladders. In the interior are all the pipe lines, safe from all external damage and weather, and most conveniently placed for inspection or repair, and every 30 to 40 feet the pipes are tapped, short branches passing out to the exterior of the pier, four cocks for compressed air, hydraulic pressure water, fresh water and gas being located in a recess in the stone work, which saves them from damage. At whatever point the men may be working in the slipway therefore, they can always connect up with their power supply, which is available within comparatively few feet of them.

The great value of this system of air distribution is very apparent. As is well known it is easy to waste compressed air. When electricity leaks, somebody gets killed, and when steam or ammonia leak they immediately make their presence felt, but when compressed air leaks no one is any the worse except the proprietor. In fact, leaks may be rathed welcomed than otherwise, if the compressed air is used in a mine, as it tends to cool the atmosphere and to improve ventilation.

Leaks of compressed air, however, like any other form of waste, cannot be tolerated in these days of intense competition, and it will easily be seen how the Govan system of air supply helps to eliminate waste of compressed air. The main and branch lines are all under the control of those whose business it is to look after them, and beyond the reach of others, and they are so well protected that leaks cannot be caused through damage from external sources. Further the distribution of the air in permanent lines is so complete that the length of flexible piping which must be used for each tool is reduced to a minimum, which also tends to air economy, as it is always easier to keep permanent pipelines airtight than flexible hose, especially when the latter becomes somewhat old or worn.

At the end of the stone piers which contain the branch power lines, the slipways are closed by portable cofferdams, so that continuous work can go on at all stages of the tide, which at this point rises to a maximum height above the slipway floor level of about twelve feet. The tide was up when the writer passed over these cofferdams, and the interior of the slipway was quite dry and the men working in the bottom. Neatness and tidiness is evidently demanded in the Govan yards, and the absence of litter or loose materials, and the men met here and there whose job it evidently was to clean up, was most noticeable.

The compressed air tools were everywhere in operation. Numbers of riveters were at work joining up the frames and fixing the plates in position. Drills and reamers, rivet heating furnaces blown by compressed air, and other pneumatic plant was at work, and a man with a chipping hammer was scarfing the plates on the sternpost of one of the larger vessels. Some of the slipways were so long that they were constructing vessels of from 12,000 to 18,000 tons in the upper part, and there was still room for the building of a steel oil barge between the stern of the vessel and the cofferdam at the end of the slipway. Some of these oil barges were in hand and a number of portable pneumatic drills and riveters were seen at work on them.

The immense glass-roofed plate shops are one of the most remarkable features of the Govan Yard. They are so light, clean, well-equipped and capacious, that the highest productive efficiency from the staff employed can be assured. The plant includes punching, shearing and bending machines of the largest dimensions and most modern design, and the machines are fitted with swing jib cranes and pneumatic hoists for handling the heavy material. Portable pneumatic tools are at work in every shop, and there are great furnaces for heating the frames for bending to iron templates by portable hydraulic rams. There are portable jibs with pneumatic hoists, as well as the stationary ones supplied to each big machine.

The whole yard is being brought to one level to facilitate inter-workshop transport. From the new plate shop a long flight of broad iron steps leads up to the layout loft, which is one of the most efficient departments of the efficient Govan Yard. This loft has a floor as level as a ballroom, and is so large in extent that it is said to be possible to layout in chalk the full sized frames of several large vessels at one time, the templates being made in wood to these chalk lines with great accuracy.

The vessels under construction in the yard at the time the writer passed through included some fine motor ships for the Glen Line. Of these the *Glenapp*, shown in the illustration, was almost completed, and she was lying with her stern in the river and her engines were undergoing some preliminary trials to test their capabilities. Six of this particular type of vessel have been completed or are in course of construction, of which the first was the *Glen-*

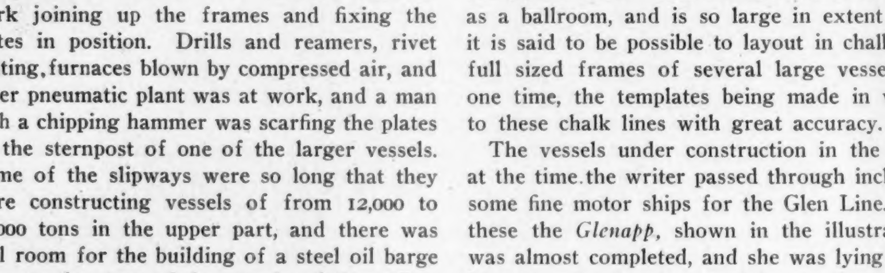


Photo Courtesy Messrs. Harland & Wolff, Ltd., Glasgow.

The "Glenapp" on her Trials, 14th December, 1920.

ogle, and it is declared that these vessels are now the largest motor-ships afloat, and have the highest powered propelling machinery.

The length overall of the *Glenogle* is 502 feet, breadth moulded 62 feet two inches, deadweight capacity about 14,000 tons, gross tonnage, about 9,150, and speed loaded about twelve and one-half knots. The propelling machinery is of the Burmeister & Wain type, adapted by Harland & Wolff, and this consists of two sets of eight-cylinder four-stroke engines driving twin screws. The engines develop together 6,600 I.H.P. The cylinder diameter is 740 mm., the stroke 1,150 mm., the engine speed 115 r.p.m., and the fuel consumption eighteen to twenty tons per day.

Each of the two engines is fitted with two air compressors mounted in tandem at the end of the engine and driven off an extension of the crankshaft. These two compressors are quite independent, and if necessary it is possible to run both engines off one pair of compressors, this arrangement being a preventative measure to guard against the possibility of compressor breakdown.

In addition to the engine air compressors, there are two special compressors for manoeuvring purposes, and these are probably the most important item of the auxiliary plant. Each of these is driven by a 180 horse-power motor, and has sufficient capacity for all ordinary manoeuvring requirements, but if at any time a greater pressure is required, the second compressor can be immediately brought to the assistance of the first.

The starting pressure used is 25 atmospheres, and a by-pass valve discharging into a silencer underneath the engine room platform is provided, to relieve the pressure if the latter should rise too high when the compressor is running. The discharge valves are operated from the control-room, and the noise of the escaping air is suitably muffled in the silencer to the benefit of everybody. The starting air is stored in three receivers situated on the starboard side of the vessel, high up in the engine room.

When docking it is usually only necessary to run one auxiliary compressor, and instead of the normal type of hand operated controller for the electric motor, it is only necessary to press a button on the case containing the electric resistances for the motor. This button brings the electric contractors into action, the contacts being made consecutively over definite periods of time. Owing to the heavy current required by the compressor motors, which each take 600 amperes at 220 volts, two positive and two negative cables are required from the switchboard for each motor, so that the cables may have sufficient flexibility.

The whole equipment of these fine motor-ships for the Glen Line is of the most modern type, and reflects the greatest credit on the designers and constructors of the vessels and machinery. The passenger accommodation and arrangements for the crew are also of the best type, and these vessels demonstrate how far motor ship construction has progressed in the last few years.

BELGIUM EMERGING WITH NEW INDUSTRIAL PLANTS

By BEN K. RALEIGH

THE LATEST facts on the recovery of Belgium indicate a long list of mechanical victories over difficulties. Thus, in the Province of Liège, 236 steel or machine works are now active, only four have not been reopened. The coke ovens of Tilleur-Ougree have started one battery as well as their by-products section. The Hoboken coke ovens have reopened. At Ougree Marihaye, where the enemy demolished the eight blast furnaces, appropriated one mixer, Thomas steel plants, seven grinding machines, twelve rolling mills and 178 electric motors, there are now four blast furnaces, four Thomas steel plants, six Martin ovens and one electric oven.

In Antwerp, "Antwerp Engineering" has launched its largest vessel, the S. S. *Winsum*, of 5,000 tons, built for foreign account. The Belliard Crighton Works, where the enemy left four walls and nothing else, are employing 1,500 men on ship repairs and contemplating enlargements.

The Belgian iron and steel industry is resuming production with the greatest rapidity. Among examples of recently resumed activities fresh blast furnaces are being blown in by the Monceau-St. Fiacre, the Thy-le-Chateau and the Providence Companies, making three within ten days; the same number of Martin furnaces are ready at La Louvière, while others are being erected. The Providence steel plant will be in complete operation by the time this is published. Rolling mills continue to increase their capacity. Extensions are being carried out at the metal works of Tubize and La Sambre, while the Baume and Marpent Company, which claimed 55 million francs compensation for war damages, is now entirely restored. Belgium has now sufficient metallurgcial coke to supply all these works regularly.

This progress, it is recorded, has been effected by good, hard common sense, hard work and loyalty. All Belgium realized that the time after the war demanded as much determination, unflinching application and sacrifice as the darkest hours of the war itself. Personal effort and personal willingness to forget self has achieved present economic advantages which, it seems, will grow in the future.

Portable typewriters have sold enormously in Belgium. The explanation is that the Belgian executive of a business is a hard worker. He labors at home over a typewriter after the day's work in the office is done. In the home, also, it is now the custom to employ the dictaphone and so continue the day's work far into the night.

The new Belgium is an efficient and up-to-date Belgium. The destruction of war has made it possible for business houses to reorganize completely in the most modern way and there have been hundreds of the largest companies which have sent representatives to the United States to study the most modern production methods.

In a recent interview M. de Wouters d'Oplinter, Minister for Economic Affairs, said:

"The Belgians have realized that salvation was only to be found in whole-hearted devotion to work. They have all understood that the only alternative to work would be starvation, stagnation and misery, instead of the welfare and wealth that are now promised beyond recall to the hard-working population of Belgium."

PLUCKY POLAND RESTORING HER COAL MINES

By DESIDERIUS ERNYEI

Engineer, Vienna

WHEN in Poland recently on a business visit I learned from Captain Fisk, a member of the staff of the American Mission in Warsaw, some of the details concerning the restoration of the country's coal mining industry, which may interest COMPRESSED AIR MAGAZINE readers.

When the Armistice was signed in 1918 and German control and operation of the Polish coal properties came to an end, the mines were faced with a tremendous problem of reconstruction. In the first few weeks of the fighting of 1914 the Germans had destroyed several of the big shafts, dynamiting winding engines, pumps and head frames. When, however, it became fairly apparent to them that they would be able to hold Poland, their policy of destruction, especially as regards the coal mining district of Dombrova, changed to one of systematic exploitation. And how the Germans can exploit! Development work, such as driving headings, was practically neglected. No new machinery was purchased and practically no replacements were made. Lubricants were scarce, and hose, belting and gaskets virtually unobtainable. Timbering was done on a minus fifty margin of safety. With a minimum of outlay the Germans obtained a maximum of output, and considering the prevailing conditions it cannot be called bad that up to the Armistice the mines were producing about 50 per cent. of pre-war output.

During 1919, with every class of industry crying for coal, the mines, under Polish direction, made renewed and desperate efforts to increase production. Shortage of food and clothing for the miners naturally created much unrest. However, by October, 1919, the Dombrowa district was producing 80 per cent. of its pre-war normal, and this has been maintained ever since, in spite of the country's troubles, with but slight fluctuations.

Early in 1920, food conditions became better. The mine owners now turned their attention to replacements and betterments. New machinery has been purchased by many of the mines which will be installed this year, and the outlook for increased production is promising.

The United States has delivered to Poland 4,500 railway cars, which are still at the Baltic port of Danzig where they are being assembled, but this work proceeds slowly. It is a drawback for the mines that the American cars are built for 30-ton loads, whereas in Poland the loading arrangements at all mines provide only for ten-ton cars. This means that the mines are compelled to rearrange their facilities for loading and shipping.

Book Reviews

DEHYDRATING FOODS—Fruits, Vegetables, Fish and Meats, by A. LOUISE ANDREA. Illustrated and containing recipes for the use of dehydrated foodstuffs. Price, $1.75. Boston: The Cornhill Company.

BOTH technical and general periodicals have commented favorably upon Mrs. Andrea's work on the dehydration of food. She treats on a subject that is of great economic importance to the world. It is one that is also of great popular interest at present. In the October, 1920, issue of COMPRESSED AIR MAGAZINE, there appeared an article entitled, *Reversing the Air Compressor to Reduce the Cost of Living*, by Robert G. Skerrett, which resulted in a flood of letters to the editors, asking for further facts and for advice. These letters indicated the interest taken in the subject, and it is pertinent here to say that such inquirers will find much of value to them in Mrs. Andrea's book.

The author gives practical directions for successful dehydration, both for homes and commercial establishments, with a complete line of recipes for cooking and serving dehydrated products of all kinds. Her advice is timely on the subject of "taking water out of the high cost of living." There is no doubt, as this authority reiterates, that perishable produce is preserved easily, economically and advantageously by dehydration, for homes, hotels, restaurants, boarding houses, schools, institutions, ships and dining cars. Pounds are reduced to ounces simply by removal of water content. Money, work, time and spoilage are saved; weight, bulk and storage space are reduced astonishingly.

MODERN WELDING METHODS, by VICTOR W. PAGE, M. S. A. E., author of *The Modern Gasoline Automobile, The A B C of Aviation*, etc. Illustrated and indexed. 292 pages. Prices, $3. New York: The Norman W. Henley Publishing Co.

THIS NEW work by Mr. Pagé already is regarded as one of the most instructive books on methods of joining metals yet published for the mechanic and the practical man. It makes no pose as an engineering book, but it offers information which a factory executive or shop man wants about all kinds of welding, soldering and brazing processes. The book considers in detail oxy-acetylene welding, the thermit process and all classes of electric arc and resistance welding. All forms of gas and electric welding machines are described and complete instructions are given for installing electric spot and butt welders.

Other features of Mr. Pagé's work are instructions on the practical heat treatment of steel and a considerable amount of tabular data is provided on tempering various forms of tools, melting points and temperature determinations.

THE BRASS CHECK, by UPTON SINCLAIR. Cloth, 448 pages. Price, $1 mail, postpaid. Published by the author at Pasadena, California.

A REVIEW of this book in the *Mining & Scientific Press*, of San Francisco, directed attention to an unprecedented arraignment of the daily newspaper, and particularly of American journalism. In his usual style Mr. Sinclair goes after his subject hammer and tongs and with foot, horse and artillery. It is roughshod reading in spots and spades are called spades. The destructive criticism of the first three quarters of the volume is offset in the last quarter of the book with what the author offers as constructive criticism. The book contains a lot of truth, too much for daily journalism's comfort. The author was correct in assuming it would not be reviewed by the dailies; that would be a bit too much to expect! But the book undoubtedly has been read, and in the future will be read with avidity by large numbers of working newspapermen and discussed in every "local room" and editorial sanctum in the land.

There are undoubtedly many reforms due in newspaper publishing. Financial necessity has its effect upon the publisher of the smaller papers, and owners of the big, successful properties feel that they must strive to keep their place and hold the business they have won. Too much truth-telling militates against them all in their most sensitive spot, the counting room. It is possible that the publishers, if they were closely leagued in carrying out wholesome and salutary policies might shake off pressure, or influence on their columns. Making public service utilities out of the news agencies and placing them under governmental inspection and control, also might aid in the matter. But owners of newspapers, even when venal, will probably not be clubbed into a different viewpoint by charges such as Sinclair makes, no matter how true they are. The work of reconstituting the public's well springs of information must be a labor of temperate and intelligent evangelism, not of muck-raking criticism.

Newspaper owners and workers are just as human and susceptible of good impulses and conduct as their present critic. Sinclair's book, however, will probably work much good, eventually, even though it is in bad taste in spots and lays him open to needless misinterpretation. The author is direct and vital, but wholly tactless, and tact plays its part in our still imperfect world. He defeats his purpose, in part, by writing with too much dudgeon and choler, and to some extent through a lack of philosophic viewpoint.

It is a book the individual must read for himself and draw his own conclusions from, for at this period of the world's development not many editors, be they never so honest intellectually, would feel justified in quoting from it. The reader will understand this after perusing this undeniably interesting and important work.

Publication Notes

The second annual pictorial number of *The Grace Log*, the handsome house journal of Messrs. W. R. Grace & Co., of New York, of which Clayton Sedgwick Cooper, writer, lecturer and traveller, is the editorial director, was a beautifully designed and printed issue. It contained scores of interesting pictures showing the activities of the Grace organization in all parts of the world. The colored front cover and other art work, together with a supplementary map in colors, showing the steamship services of the Grace lines and the Pacific Mail, made it doubly attractive.

A new pamphlet entitled. *The Air Brake Family*, has been received from the Westinghouse Air Brake Co., Wilmerding, Pa. This interesting brochure describes the various agencies that have been established to promote the general well-being of the employee and to facilitate for him pleasant and harmonious industrial relations with the company. The booklet carries a portrait of the founder of the company, the late George Westinghouse, as its frontispiece. Other large industrial concerns are sure to find some helpful suggestions and ideas in this booklet, which may be obtained by writing Mr. S. C. McConahey, Acting Vice President, at Wilmerding.

The Bureau of Mines of the U. S. Department of the Interior, has issued Bulletin No. 117, entitled *Structure in Paleozoic Bituminous Coals*, by Reinhardt Thiessen. It is a highly valuable treatise, of which this is the first edition from the press of the Government Printing Office, and it must certainly find a place in every coal mining library. It is filled with geological interest and its plate illustrations are noteworthy.

We recommend to readers interested in the subject Bulletin No. 120 (Petroleum Technology 23) on *Extraction of Gasoline from Natural Gas by Absorption Methods*, prepared by George A. Burrell, P. M. Biddison and G. G. Oberfell. Many gasoline men have found this bulletin an invaluable aid.

An article by M. L. Requa on *The Petroleum Problem*, which appeared originally in the *Saturday Evening Post*, has been reprinted and distributed privately. It contains the fundamentals of the petroleum problem not only of the United States, but of the entire world. The Union Petroleum Company of Philadelphia has also reprinted an address by Mr. Requa, who is vice president of the Sinclair Consolidated Oil Corporation, that was delivered before the American Petroleum Institute, on the subject of "Conservation," and in which the speaker took up specifically the subject of oil.

We have received from Bernard M. Baruch a reprint of his address delivered on the occasion of the reunion of the members of the War Industries Board at Washington, which was recently commented upon in these columns.

American pig iron production in 1920, according to the *Iron Age*, was 36,414,114 tons, not including charcoal iron, compared with 31,004,500 tons in 1919, and 30,052,000 tons in 1918, the latter being a high annual production.

It is reported that conditions in Cuba are improving and that in a short time the island will be in good financial condition. A number of banks have sent large shipments of currency to Cuba, stabilizing financial conditions to a great extent.

COMPRESSED AIR TO DRIVE A FORD AUTOMOBILE

A CORRESPONDENT in Oklahoma City, Okla., W. A. De Long, has written to us the following inquiry:

"Will you kindly tell me how far an air bottle three feet long and one foot inside diameter charged with air at 1,000 pounds per square inch will propel a Ford running gear, using a reheater for the air, and also without a reheater? Would it be practicable to use a turbine on the rear axle?"

We may as well say frankly that it is not worth while to go into this question very deeply. The power required to drive a Ford for any distance, at any speed, and upon any kind of road is a very uncertain and a highly variable quantity. The capacity of the "bottle" suggested by our correspondent would be 2.35 cubic feet and this volume of air at 1,000 pounds would be equal to a little more than 150 cubic feet of free air.

It is understood that the air is compressed to this great pressure just for the purpose of storage and a portion of the power represented is lost at once by the crude arrangement most likely to be employed for its use. It would have to be expanded down to, say, about six atmospheres, or 75-pound gage, to use it in any ordinary type of reciprocating motor. The 150 cubic feet of free air would then become 25 cubic feet at 75 pounds and the tabulated power cost per cubic foot at this pressure is a little less than one horse-power minute, or 25 horse-power minutes for the whole volume.

As not more than 25 per cent. of the power used in the compression would be realized in the power returned, the actual power for propelling the Ford would be one horse-power for six minutes.

The problem is by no means as simple as we here state it, but the result is sufficiently indicated. Reheating of the air would not be practicable and would not help the matter at all for such service as this.

As to the use of the turbine which our correspondent suggests, we are confident that much more power could be realized in that way. By a system of induced currents of air the volume might be vastly increased and the pressure from the very highest point would be made to tell, but the entire arrangement would have to be designed or invented from the beginning, and it would be a job too big for any normal amateur.

COMPRESSED AIR SOCIETY NAMES COUNCILLOR

F. K. Copeland, president of the Sullivan Machinery Company, has been named new national councillor of the Compressed Air Society of New York, to represent it in the Chamber of Commerce of the United States. The National Council of the Chamber of Commerce of the United States consists of one representative each from the more than fourteen hundred commercial and industrial organizations making up the National Chamber's membership. It serves as an advisory body to the National Chamber's Board of Directors.

The Council holds a special meeting preceding the annual convention of the National Chamber to pass on the programme and to select a nominating committee. The councillors also act as chairmen of the delegations representing their organizations. A councillor occupies a position of *liaison* between the National Chamber and his own organization on important questions.

AIR ALLEVIATES TORTURE IN PARIS BEAUTY SHOPS

Edna Kent Forbes of Paris tells, in one of her "Beauty Chats," how compressed air is used to lessen the discomforts of ladies undergoing the painful process of the "permanent artificial hair wave" at the hands of the Parisian beauty experts. Miss Forbes watched the process, which takes six hours, during the period of which milady may read a book to pass the time.

The comeliness exponent tells how the hair is first shampooed and partly dried, a special soap being utilized which is suspected of being very drying in its effect. The hair is next parted into strands and rolled around small objects that resemble thread spools. As there is a considerable art or knack to winding the hair on these spools the patient feminine sacrifice on the shrine of beauty is asked how many spools she desires, and is charged accordingly, also enough. The coiled hair is tied firmly to each spool with string and when all the spools have been prepared, the head is covered by a sort of cap which is attached by long wires to an apparatus in the ceiling. The wire convey electric current to resistance coils within the spools and thus the hair is "baked" into waves. Sometimes a liquid is put on the hair to induce steam from the heat generated.

It is a tropical experience for the patient, for a great deal of heat is generated in the spools. The whole apparatus looks like some device of the Spanish Inquisition. This is where the compressed air comes in, for an operator stands beside the victim and blows a current of air from a rubber hose over the scalp to alleviate the suffering. Every beauty parlor or barber shop in Paris may have compressed air at its command, for it is piped through the streets just as gas and water are in other cities.

COMFORTS FOR SEAFARING MEN AT NEW YORK

Seafaring men are notified of a memorandum issued by the American Seamen's Friend Society, of which the main office is at No. 76, Wall Street, New York, (Telephone: Hanover, 6498) which describes the comforts and conveniences provided for sailors at the Port of New York. At the request of maritime readers we reproduce this memorandum:

1. The Loan Library Department: When American merchant ships arrive in ports, our Ship Visitor goes on board, makes direct contact with the officers and crew, and leaves a loan library for their use. This service can be obtained by notifying our Librarian of the arrival of the ship and the location of her pier, with full directions for reaching it.

2. Relief of Shipwrecked and Destitute Seamen: Those who are brought back to this port, having lost their dunnage, are given food and lodging and the clothing necessary to reship upon satisfactory evidence of need.

3. Support of Affiliated Work in other American Ports and abroad. The Sailors' Home and Institute, No. 507, West St., Telephone: Chelsea, 8058. It is a complete "home" in every sense of the word. The rooms for officers cost $1.25 per night and those for men 50c. They are comfortable and absolutely clean. Officers' rooms should be reserved by telephoning the Sailors' Home.

Though we have no shipping bureau, the spare man for a crew is apt to be found at the Sailors' Home. Telephone for him.

There is a hostess, who, in addition to her daily work among the men, leads their singing at the weekly concerts and visits them when ill. Requests for hospital visitation can be sent to the chaplain, the Rev. James C. Healey at the Sailors' Home, No. 507, West Street.

Other requests for special service to seamen should be sent to the secretary of the society, the Rev. Dr. George S. Webster, No. 76, Wall Street, New York.

THE STANDARD TON OF REFRIGERATION

A SPECIAL committee of the American Society of Mechanical Engineers was recently appointed to fix a "Standard Tonnage Basis for Refrigeration." Its findings were as follows:

(1) A standard ton of refrigeration is 288,000 B.t.u.

(2) The standard commercial ton of refrigeration is at the rate of 200 B.t.u. per minute.

(3) The standard rating of a refrigerating machine using liquefiable vapor is the number of standard commercial tons of refrigeration it performs under adopted refrigerate pressures.

A refrigerating machine is the compressor cylinder of the compression refrigerating system, or the absorber, liquor pump and generator of the absorption refrigerating system.

These pressures are measured outside and within ten feet of the refrigerating machine, distances which are measured along the inlet and outlet pipes, respectively; (*a*) the inlet pressure being that which corresponds to a saturation temperature of five degrees fahrenheit (—fifteen degrees cent.) and (*b*) the outlet pressure being that which corresponds to a saturation temperature of 86 degrees fahrenheit (30 degrees cent.).

The ninth annual meeting of the Chamber of Commerce of the United States will be held at Atlantic City from April 27th to 29th, inclusive. From 3,000 to 4,000 business men are expected to attend.

It is reported that a complete agreement has been reached between the British and French governments on the desirability and wisdom of extending aid in the rehabilitation of Austria.

The average amount of air for the complete combustion of fuel oil is about 14 pounds of air to 1 pound of oil, or 183 cubic feet of air at 60 degrees Fahr.

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Correspondence invited from engineers, chemists, experimenters, inventors, contractors and all others interested in the applications, practice and development of compressed air. Correspondents and contributors will please submit questions, or matter for publication, accompanied by self-addressed stamped envelope; they also will please preserve copies of drawings or manuscripts as we cannot guarantee to return unavailable contributions in the event of rejection, though our practice is to exercise diligence in doing so.

EDITORIALS

GIANT DRILLING JOB AHEAD TO RELIEVE N. Y. TRAFFIC

COMPRESSED air will be called upon heavily before the expiration of the next decade in the process of vastly extending the underground transportation system of the metropolitan area of New York, the world's greatest population centre. Present facilities for handling more than 2,360,000,000 passenger rides per annum are woefully inadequate, and the situation is getting constantly worse because the population increase is on a rising ratio to transit facilities.

Mr. JOHN H. DELANEY, Transit Construction Commissioner, in submitting his annual report to the Legislature of the State of New York, says that the growth of traffic on the rapid transit lines has exceeded the annual per capita increase in population, and that an enlarged system to care for the needs of the people during the next 25 years will have to provide for an annual traffic of five billion at an estimated cost of $350,000,000 at present prices, or $175,000,000 at pre-war prices. In addition, it will cost about $200,000,000 for facilities and equipment.

Vehicular and pedestrian traffic in New York's streets is increasing at such a pace, Mr. DELANEY finds, that it soon will be regarded as inadvisable to continue surface car operation. It will be necessary, for more than one reason, to resort to double-deck subway trunk lines in the central traffic arteries of the metropolis that still remain available for transit routes. In the report the following comparative figures are presented, showing the increase in passenger traffic for the fiscal years ended June 30, 1919, and 1920:

	1920	1919
*Rapid transit R. Rs.	1,424,166,581	1,204,266,664
Surface lines	940,608,486	875,676,340
Total	2,364,775,067	2,079,943,004
Increase	284,832,063	104,430,815

*Including Hudson and Manhattan tubes.

"These figures," the report explains, "disclose that there was an increase of approximately 220,000,000 passengers in the rapid transit traffic during the fiscal year just ended, of which all but 9,000,000 of the increase was carried in the subway and elevated lines, making up the dual system in which the city has a large financial interest. The business of the Hudson & Manhattan tubes between Manhattan Borough and New Jersey shows an increase of about 9,000,000 passengers on a total traffic of approximately 90,000,000. The increase in passenger travel in 1920 over the increase in 1919 was approximately 175 per cent."

Deep rock drilling operations, by means of compressed air equipment, will be required over a period of years to construct the required new traffic arteries beneath the street surfaces, since all Manhattan is reared upon solid rock, and especially if double-deck subway lines are determined upon by the transit authorities. The latter plan would call for one tier of tracks for local service, and a secondary tier of tracks beneath for express service. It has been proposed that each of the tiers have four sets of tracks, so that there could be two sets of "locals" and two sets of expresses running simultaneously in a given direction. This would constitute a double-service subway, having a capacity twice that of any of the existing lines. Students of this idea are hopeful that it will be adopted. Engineers have also proposed that each single set of rails shall be walled up on either side, so that each train passing through will act as an air plunger that will keep the tubes well ventilated and at a comfortable temperature, especially in summer, when the effects of the heat generated by the electric motors is highly noticeable in the existing subways.

The new twin tubes being built for vehicular traffic beneath the Hudson River, connecting Manhattan Borough with Jersey City, which were described so interestingly in these columns last year by Mr. SKERRETT, are designed to relieve river ferry traffic, street traffic congestion in New York, and to make Manhattan Island independent of bad weather and labor troubles with marine workers. Street traffic is now so dense in New York that every remedial agency or expedient, if only of a temporary nature, is seized upon by the city's engineers and the traffic police. Much interest is shown therefore in Mr. DELANEY'S suggestion that surface car trolley traffic will soon have to be abandoned entirely. Aside from the obvious traffic benefits to be dervied, such cessation of trolley traffic would greatly increase the real estate values on many important thoroughfares and would greatly lessen the din of the streets, now so nerve-wracking. The next step will be the abolition of the elevated structures, which many engineers believe never should have been constructed originally, but which nevertheless for many years have served the city well. They are obstacles to safe traffic, great noise-makers, and they depreciate property values. They also shut out light where it is greatly needed in congested sections of the city.

New York will find itself forced to embark upon a new and modern transportation era in the near future, and when a comprehensive policy or plan is once officially adopted, ten million people will sigh with relief in anticipation of a reduction of the present intolerable transportation jam.

EXPERIMENTS IN EXTREMELY HIGH PRESSURES

IT IS not altogether clear what it is leading to, but we are becoming experimentally familiar with much higher pressures for air and the gases, and also for the various liquids and solids, with interesting and suggestive results accompanying them and enticements to go further in the same direction if it can be made possible.

The most notable experiments in this line to date are those of Dr. P. W. BRIDGMAN in the Jefferson Physical Laboratory of Harvard University. In these experiments pressures above 20,000 atmospheres, or, say, 300,000 pounds per square inch, were attained. The pressure, using water as the medium, was

produced by means of a cylinder having a piston with a packing which grew tighter as the pressure increased. The best material for the piston, to stand the compression stress, was found to be hardened tool steel, which could sustain pressures of from 600,000 to 750,000 pounds, far beyond any data in the standard tables.

To prepare the cylinder for the tensile strain it was first subjected internally to a higher pressure than it was expected to work under. This, by compressing the container outwards, stretched or expanded the interior. It was then rebored sufficiently to true it, and it was then in the condition of a gun over whose inner tube hoops and jackets have been shrunk. Chrome-vanadium steel, oil-hardened, was the best material found for the cylinder.

The pressure reached in the experiments would approximate the pressure of water at a depth of 120 miles, or of the solids of the earth at a depth of, say, 50 miles, so that the interior pressures of the earth must still far exceed anything we are ever likely to produce, and in the sidereal bodies of vastly greater mass the internal pressures must be to us practically inconceivable. When matter is absolutely confined, so that it cannot escape in any direction, there can be no limit to the pressures it may sustain, and there is therefore more or less of a suggestion of absurdity in our published tables relating to compression strengths. Nevertheless, the strengths of materials as we know them seem to indicate the limit of pressures attainable by artificial means. In this direction, as in every other, our experiments and speculations simply give us a glimpse of the forever unattainable. *R.*

IS AMERICA PAYING HEED TO SUBMARINE NEEDS?

AN ARTICLE in the January issue of COMPRESSED AIR MAGAZINE written by Capt. YATES STIRLING, JR., of the United States Navy, has attracted much interest in naval circles of different countries. It was an article dealing with the uses of compressed air on board modern submarines, and technical in a sense, but it also considered the future of the submarine and sounded a warning that this weapon of offense and defense must not be neglected. In the light of the German Admiral VON SCHEER's more recent utterances, the American naval officer's views have added significance.

Captain STIRLING declared:

"The nation with the most efficient and numerous submarine force, comprising vessels of seakeeping types, will be a very dangerous enemy for another nation to attack. The United States with her long coastline and her vital interest in the sea cannot afford to neglect this weapon. * * * The General Staff of our next enemy may be keeping itself informed of our unpreparedness and quietly and silently preparing its navy for a conflict with ours."

Other pertinent paragraphs were:

"Many authorities predict the coming importance of the submarine. Admiral Sir PERCY SCOTT and Admiral Viscount BEATTY are quoted to have stated that even a submarine battle cruiser is not beyond the bounds of probability.

"* * * This * * * naval weapon of war in its modern form (was) invented by an American but developed most artfully by the Germans and the British. The Americans have failed to hold the lead which the inventor put in their hands. They seemed content to follow and unfortunately not too closely the foreign navies in the development of this type of ship. Some day we shall *all* see the vital necessity of a most efficient submarine service but that day may be too late to correct our errors."

Admiral VON SCHEER commanded the German sea forces at Jutland. Lately he has declared that "surface ships are tremendously expensive and yet they are very vulnerable." He observes that hitherto only a few nations could afford these big ships, and so they ruled the sea. "But the submarine has knocked all this into a cocked hat and fear of the British fleet as a fighting weapon has gone!" He advances the general principle that a great surface fleet can no longer protect a coast or overseas commerce and that submarines can best defend or attack a coast and can best protect or destroy commerce. In short, concludes VON SCHEER, an adequate submarine navy will enable a comparatively weak nation to pursue an overseas policy *without worrying about a surface fleet.*

Lord ROTHERMERE, formerly director of England's air force, has published an article, *The Folly of the Big Battleship.* He declares in his article, referring to the United States and Japan: "They are obviously building against each other and not against us. Great Britain cannot afford to spend money on naval construction at present. If the United States and Japan persist in pursuing antiquated forms of warfare that is no proof that capital ships will survive. No nation henceforth will enjoy naval supremacy. It is a nasty pill, but we must swallow it."

In the opinion of the New York *Tribune* such assertions, based on experience in the Great War—that submarines and aviation have revolutionized naval warfare—cannot be overlooked. Surface ships are between two dangers, one from below, the other from above. There is as little reason to doubt the danger from aerial craft as there is to doubt the effectiveness of the submarine. It is the part of discretion that the United States Government shall heed the warning not only of Captain STIRLING, one of its own able officers, but of alien authorities. It is a pertinent question raised by the *Tribune* as to whether these modern theories are being intelligently considered in Washington by those who are urging the unrevised completion of the "building programme of 1916"—a programme five years old.

JINGOES AS THE ENEMIES OF WORLD PEACE

A SMALL number of Americans, comparatively, realize or appreciate the importance of the commerce of the United States with Japan; otherwise they would not listen with credulity to the "loose talk" of a possible conflict between the two countries.

Many of the unnecessary international frictions could be avoided if each nation were to give to others a little more credit for honesty of heart and purpose.

Jingoism is to be condemned, because all nations have suffered from it, including Japan, which like the rest of the world has been misunderstood and misinterpreted. Sometimes ignorance of a foreign country and a tendency to over-estimate the intelligence of the people of another country are responsible for mutual suspicions and misunderstandings.

The American people who are finding fault with Japan are those who have never been there and who are not acquainted with the real feelings and disposition of the Japanese. Americans in Japan who have studied the situation there know that the leaders of Japan are eager for American friendship.

* * *

The foregoing four paragraphs sum up some of the principal thoughts expressed at the dinner of the Japan Society in New York in honor of Baron K. SHIDEHARA, Imperial Japanese Ambassador and Mr. ROLAND S. MORRIS, American Ambassador to Japan, and Mrs. MORRIS. Judge ELBERT H. GARY, Chairman of the Board of the United States Steel Corporation, declared that the jingoes in Japan did not represent the true sentiment of the people of their country, any more than do American jingoes reflect the feelings of the majority of the people of the United States. He went on to say:

"One of the things complained of is that the Japanese are increasing their navy, which is thought to mean only one thing—preparation for war with the United States. If that is good argument for war, I want to inquire what country there is in the world with a sea and with money to spend on ships that is not preparing for war with the United States and other countries.

"Isn't it fair and reasonable to judge Japan by ourselves? What are we doing? Is there any other nation in the world that is building as many instruments of warfare for conflicts unforseen? Aren't we the chief offenders, if there are any?"

Judge GARY declared that trouble-makers in America assumed that the Japanese were trying to force themselves in large numbers on the United States as a place for residence. He declared that this was not so, and said that Japan recognized, as we did, that any country had a right to exclude foreigners from its territory. What the Japanese resented, as a matter of fact, was being discriminated against.

Ambassador SHIDEHARA said that it was his opinion that the peace of the world depended not so much on the niceties of diplomatic instruments as on the spirit of good faith and good will between nations, and said that no treaty, no arrangement of any kind, could serve as an absolute assurance of peace, if nations were mutually suspicious or spiteful.

All of the sentiments expressed on this helpful occasion of international amity may well be digested by the peoples of all countries. The whole world needs a strong allopathic dose of the Christmas spirit: "Peace on Earth; good will toward men."

INTEREST ON BANK DEPOSITS, A RETURN FOR SERVICE

IT IS PROBABLE that in no period of the world's history has the iconoclast been busier than during the last few years—and he has now tackled banking. If you happen to live in a city where there are numerous good strong national banks all looking for deposits, wouldn't you be likely to place your account with the one that offered you the most inducement?

Granted that you are a bank depositor to the extent that you always maintain a satisfactory balance; that you are sometimes a borrower who has perfectly good collateral to offer and a perfectly good reason to give for wanting accommodation, and that your record is clean and straight in that you always "make good," there is little inducement that any one national bank in your community can offer you that cannot be offered by any of them. Your choice, then, will be with the institution that is most convenient to your place of business, or where the paying teller greets you with a smile instead of a scowl and knows your name when you present yourself at his wicket.

These are about the only reasons that can sway your choice for one can offer no special inducement over the others as to rate of interest or other monetary consideration. Any of them will take your deposit money gladly; they will lend it out to eligible borrowers at a profit to the stockholders, and will pay you apparently nothing, or next to nothing, for the use of it other than in the service which it renders.

One may feel safe in saying that the national bank conditions described are universal —except in just one city—Cleveland, Ohio, where the iconoclast has gone into banking. His name is the Brotherhood of Locomotive Engineers and his bank is just only started. It is a new role for him—this posing in the dual capacity of Capital and Labor. He has organized a national bank—capital $1,000,000 and $100,000 surplus. There is reason for thinking it will be a success because, being a national bank it is, ipso facto, a member of the Federal Reserve system and also comes under the stern and uncompromising regulation of the Comptroller of Currency, and cannot well go wrong.

Our iconoclast made a bold stroke when he thus merged Capital and Labor into a composit one, so to speak, and started it out in national banking. He did much more than this, for he broke the age-old precedent which says that stockholders shall make all the money there is in banking, for he promises to let the depositors participate in profits. But do the stockholders make all the money, or is this a misapprehension?

The Brotherhood bank of Cleveland announces that it will pay, when earned, ten percent to its stockholders and stop there. Anything in excess of ten percent, when earned, will be divided among the depositors. 51 per cent of the stock of this bank is owned by the Brotherhood and the balance by members of that order. All of the directors are Brotherhood members.

What will be the effect of the successful operation of a bank that offers depositors such an inducement? Will it revolutionize banking once it gets in full motion? Will other institutions follow suit? Will they capture the deposits that formerly went to other banks?

In the *Organized Farmer*, a Western publication of recent date, Dr. FREDERIC C. HOWE made a most violent, unwarranted and misleading attack upon the bankers and the banking system of this country. He claimed that the banking business is carried on, the country over, in the exclusive interests of big business to the exclusion of the farmer; that even the smallest country bank is but "a sucker, a feeder, a little sponge that draws to itself the resources of the country, the village and the town, which resources are used in turn by the big exploiting banks of New York." Dr. HOWE is a college professor and a man whose say so carries more or less weight for this reason, but his attack was so manifestly unfair, and, if left uncontradicted, would do so much harm that Mr. GEORGE E. ROBERTS, vice president of the National City Bank of New York undertook to answer him in *Nation's Business*, and did so very ably. There was one statement made by the doctor, however, that Mr. ROBERTS did not attempt to answer, though he might have done so. This is it. "The banker really borrows the depositor's money, usually for nothing, and lends the same money back again at from six to ten percent interest. This is why banking is profitable. They supply but a portion of the capital themselves in the capital stock of the bank to which they subscribe. But almost all of the money they have to control is the money of other people placed in their hands for safe keeping."

This is a very popular and taking statement but it is misleading because it is only partly true as are most of the statements that Dr. HOWE makes. Ask any commercial house, large or small, whether the service it receives from its national bank of deposit isn't worth many times more than any direct interest it might receive on its daily balances. Such service enables these houses to carry on a business often ten or twenty times the amount of its balances in which there is frequently a profit of ten, twenty, or 30 percent. Without such service this business would be impossible.

The Brotherhood bank may solve the problem of letting the depositor in on interest earned by his deposits. It is an old story—often tried—but never so successfully that the practice has taken root.

There are few people, unless they be of the Dr. HOWE type or out-and-out Bolshevists, who do not agree that the bankers of the country handle the funds entrusted to their care honestly and with the best interests of the country at large at heart. There are many, however, who would be glad to see some direct and substantial returns from the deposit moneys that make bank profits possible, and the bank that solves this question—and does it successfully—will capture the business in the end.

THINKING AS AN ASSET IN THE BUSINESS GAME

A RECENT article in the *Grace Log*, the excellent house journal of Messrs. W. R. GRACE & Co., of New York, treated of the subject of mental gymnastics in connection with sound business, and quoted the reported saying of Sir JOSHUA REYNOLDS: "There is no expedient to which a man will not resort to evade the real labor of thinking." The writer comments on such phrases as "executive ability," "speaking ability," "selling ability," and the like, as having become shopworn, and suggests that the phrase "thinking ability" is not so frequently appreciated. The arguments that follow are worthy of reproduction, we believe.

Our attention is directed to the undoubted fact that the age in which we are living has a tendency if not to destroy entirely, at least to minimize the average man's power to think through his work. No argument is needed, however, to convince anyone of the necessity for a successful business man to procure perspective upon his work, to organize his ideas and his endeavors intelligently, and thus not only to build his business constructively, but to obviate false motions and the needless expenditure of energy.

All this is dependent upon thoughtfulness and requires taking time to form the habit of clear thinking. It is worth every man's time to consider occasionally whether he is more active than he is thoughtful. A man may be very busy seemingly, yet his output of accomplishment may be small. It depends upon whether he is working upon a well-thought-out plan.

There are many tendencies of our times which hinder the formation of thinking. It is a period of predigested thought; the mind is not urged to work enough. We take our opinions too easily from the illustrated press and picture supplements, from the "movies" and from second-hand opinions of other men.

Our commentator tells of reading recently an article in a trade journal written by an advertising man who advocated a universal appeal to the five senses in advertising, rather than to thoughtfulness, since he declared the average man is most concerned through the impressions he gets through his five senses. In other words, the inference follows that human beings are reverting to Darwinian types, and the man with ideas, with the power to think and create for himself, to see visions and dream dreams, and to originate new ideals for his work, is "conspicuous by his absence."

Whatever truth there may be in this advertising reasoning, it remains a fact that the leader to-day in any realm of affairs is the man who has taken time to learn how to think. Successful men in business still, to use the answer of a famous artist, "mix their colors with brains."

The writer of the article from which we have quoted says that he has always been impressed with the reply of a certain member of the Grace organization, who when asked for suggestions concerning an important matter, is quite likely to remark, "Let me take it home; I want to think about it." That house had

grown to its present status, not by chance, but by reason of the fact that its leaders possessed the ability to think, to construct, to build upon firm and lasting foundations. Activity, of course, is indispensable, but successful men use their brains as well as their heels.

In line with this same subject Mr. THOMAS A. EDISON, in an interview recently published in the *American Magazine,* declared that the reason so many men "never amounted to anything in the world" was because they didn't think. The New York *Sun,* in referring to the matter editorially, cited a common saying in America, "I never think; it's too much like work." And in these days of proceeding along the lines of least resistance, no doubt cold, logical thinking is the hardest kind of hard work for the people whom industrial and business leaders are endeavoring to shake out of their mental and physical lethargy.

The old-fashioned idea of executive direction by pompous methods such as were expressed in the saying of a superior to an underling, "You are not paid for thinking; I do all the thinking around here," has passed into the discard along with other antique notions of bygone business. "Use your bean" is the inelegant but forceful command of business to-day, and the advice is freely extended to everybody, from the office boy up to the topmost boss.

A writer once complained to MARK TWAIN that he had half way completed a story, but could not invent the remainder of it. "Have you tried concentrated thinking?" was the mild inquiry of MARK. In this suggestion lies the answer to many knotty problems of everyday affairs. Not always popular advice, good results are certain from it, provided it is followed consistently.

MR. BAIN NAMED CHIEF OF BUREAU OF MINES

Dr. F. G. Cottrell, Director of the United States Bureau of Mines, who presented his resignation to the President, through Secretary Payne, left the bureau to become chairman of the Division of Chemistry and Chemical Technology of the National Research Council. Dr. Cottrell recommended as his successor H. Foster Dain of California, whose name was formally presented to the President. President Wilson later nominated Mr. Bain.

Mr. Bain was educated and trained as a geologist and mining engineer. He was one of Herbert Hoover's assistants in London on the Belgian relief work during the war. Before that he was editor of the *Mining and Scientific Press* of San Francisco, California, and later the editor of the *Mining Magazine* of London. He made some important mining investigations in South and Central Africa and later undertook similar investigations in China. At one time he was a mine operator in Colorado and once was connected with the United States Geological Survey. Subsequently, he was the first director of the Geological Survey of Illinois.

For a time during the war Mr. Bain was assistant director of the United States Bureau of Mines, following up production and manufacture of metal products, explosives and other chemical substances for war purposes.

H. Foster Bain.

Mr. Bain was born at Seymour, Indiana. Graduating from Moore's Hill College, Indiana, in 1890, he spent two years at Johns Hopkins University and later received his doctor's degree from the University of Chicago. He has been for many years a prominent and active member of the American Institute of Mining and Metallurgical Engineers, the Mining and Metallurgical Society of America, and the American Mining Congress.

AMBROSE APPOINTED CHIEF PETROLEUM TECHNOLOGIST

A. W. AMBROSE, the recently appointed chief petroleum technologist of the Bureau of Mines, has been distinguished in the field of geology particularly in relation to drilling and production for a number of years. He was born in Lockeport, Calif., in 1889, and graduated from the College of Mining of Leland Stanford, Jr., University, in 1913.

A. W. Ambrose

Mr. Ambrose's early work was in the California oil fields where he spent three years, and later he was engaged in the Louisiana and Texas oil fields. He served in Washington for two years as assistant to the chief petroleum technologist and afterwards was stationed at the Bartlesville, Okla., station doing petroleum investigation work. He became superintendent of that station only a short time ago and now has been summoned to take charge of the petroleum work of the Bureau.

Attention of interested readers is called to errata in the article entitled *Tapping the Atmosphere for Needful Nitrogen,* published in the December, 1920, issue of COMPRESSED AIR MAGAZINE. On page 9890, line 7, column 1, substitute "platinum" for the word "aluminum." Page 9891, line 6, column 2, should read "both Plants Nos. 1 and 2 in the Muscle Shoals district." Plant No. 1 is actually situated at Sheffield, Alabama.

MARBLE IN GUATEMALA*

By OLIVER BOWLES

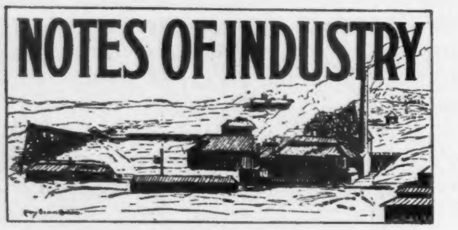
The American Consul at Guatemala City reports that the Guatemala Marble Mining Company is preparing to operate a marble quarry about 13 miles from the railroad station of Zacapa, which station is a little over 100 miles from Puerto Barrios, the nearest port from which the product may be shipped. The deposit is extensive, and though somewhat broken up in places, great quantities of sound marble are available. It is claimed that the marble is equal in quality to the best product of the Italian Carrara quarries.

Access to the quarry by rail is obtained by a spur track of the International Railways of Central America (Ferrocarril Internacional de Centro America) from Marmol, 3 miles south of Zacapa. This spur is about 5 miles long and it terminates at the foot of the mountains. A double-track incline cable-way 2000 feet in length has been constructed to bring the marble down the mountain. From the top of the incline to the quarry there is a railway six miles in length over which the rock will be hauled by two side-geared Shay locomotives.

A hydro-electric plant, laborers' houses, ware-houses, work-shops and other buildings necessary for quarry operation are already built. A ten-gang marble sawing mill is now in process of erection under the superintendence of two marble workers from Rutland, Vermont. It is claimed that over a million dollars have been expended in connection with the enterprise during the past seven years.

Shipments up to the present time consist of only one sample consignment of fourteen tons to England, but it is believed that production on a considerable scale is about to begin. A steamer has been secured and arrangements made for shipment of the marble to New York City.

(*U. S. Bureau of Mines Reports of Investigations.)



In America

The Western Union Telegraph Company has placed in operation between New York and Seattle, Wash., what is probably the longest transcontinental telegraph wire in the world, as it spans 3,381 miles. This linking up of business and industry from coast to coast of America on one circuit is accomplished without manual relays, mechanical repeaters being used to send the impulses. It is a "printer" type circuit, such as is used largely in Europe and also by submarine telegraph companies, the operator stamping out a tape and machines doing the rest of the work. The route is from New York to Chicago, thence to Minneapolis, Helena, Spokane and Seattle. The termini of this single strand of copper wire, which at eighteen cents a pound cost $125,000, are equipped with the most modern multiplex, which permits of the transmission of four messages simultaneously each direction. The line has a capacity of 225 messages an hour. The cost of construction, labor and material for the line was said to have been $70 a mile. It means fast communication from New York with the north Pacific Coast and Alaska.

The average production for each underground worker employed in the coal mines of the United States during 1918 was 1,134 short tons, according to statistics published by the United States Bureau of Mines. Our closest competitor is New South Wales, where each underground worker in 1918 produced 814 tons. The smallest individual output of recent years was that of Japan in 1917, with an average of 155 tons.

Recent progress in gasification processes are said to have made it possible to obtain out of the 30 million BTU's in a ton of coal, eight to nine millions in gaseous products, three and one-half millions in liquid products and fifteen millions in the coke.

The study of the manufacture of oxygen from the point of view of the engineer is being undertaken at the Harvard Engineering School under the direction of Prof. Harvey N. Davis. This study is made possible by a gift to Harvard of $5,000 from the Research Corporation, founded through the efforts of Dr. F. G. Cottrell. Professor Davis and his associates expect to put the designing of oxygen plants on an engineering basis, so that their efficiency can be estimated as definitely as that of a steam engine.

The United States Navy has commissioned the world's finest war vessel, the *California,* built at San Francisco at a cost of $15,000,000, and considered the greatest fighting ship afloat. The ship is commanded by Capt. H. J. Ziegemeier, The *California* is the third electrically driven ship of the U. S. Navy, and the second to be manned by sons of the State for which she is named. She is 608 feet over all, 97½ feet beam, 33,000 tons displacement and will go 21 knots an hour. She carries a main battery of twelve guns of fourteen-inch calibre, and her secondary battery has 22 five-inch rapid fire rifles, other smaller guns and six torpedo tubes. The ship uses compressed air extensively. Oil is burned as a fuel to generate electricity.

Since the dawn of the new year the United States Government has been advised by both its military and its naval observers abroad not to participate in any disarmament programme as of the *status quo.* Exporters and bankers are pondering upon this advice.

The *Weekly Bulletin* of the American Manufacturers Export Association, of which Mr. William C. Redfield, formerly Secretary of Commerce, is president, published in one of its January issues an article on *Mexico as a Market for U. S. Exporters,* by Mr. William F. Saunders, Secretary of the American Chamber of Commerce in Mexico. The article, which contained much valuable and interesting material, stated that Tampico would ship 140,000,000 barrels of oil this year, and that the output of silver would be 75,000,000 ounces.

Many engineers are firmly of the opinion that lacing must be used on belts, exposed to steam as, for instance, belts used on pulleys in laundries, etc., that belt cement will not hold under such conditions.

That all depends on the kind of cement used. Not all belt cements are made of the same ingredients. Steam will not dissolve a belt cement made on a pyroxylin base because it is waterproof; therefore, not affected by moisture.

In Europe

The British Air Ministry's Department of Civil Aviation announced recently a trial flight for one of its new passenger airships. These two craft, the R-36 and R-37, are 672 feet long and have a gas capacity of 210,000 cubic feet. They have a gas lift of 63.8 tons and a useful lift of 22.5 tons. They will be able to make from 60 to 66 miles per hour, each ship being fitted with four 350 horse-power engines. The R-36 is fitted to carry 50 passengers in compact sleeping quarters with tiny lounges, attached bunks and wash basins. Meals will be served from electric stoves. The experimental flight is expected to develop valuable data for commercial air traffic companies.

The French have discovered that in the island of Madagascar are some of the world's richest deposits of radium-containing minerals. M. Lacroix, the discoverer of the deposits, and now Secretary of the Academy of Sciences, says the radioactive minerals belong to the group of titano-niobo-tantalates, of which he has named the principal betafite, from the district in which it is found. This dark brown mineral is shipped to France where the radium salt is extracted. A camera and a gold-leaf electroscope are used to detect the presence of radium in the minerals. The present price of radium in France is 1,000,000 francs per gram.

There is increasing activity in the aircraft industry in Fr.ance and Germany, but a decline in England, according to a survey by the British Government. This will be a surprise to Englishmen, since general opinion has been that Britain would achieve world supremacy in the air.

The *Industrial and Commercial Gazette* of Berlin declares there will be an open ocean freight rate war between the transatlantic lines of England and America, with German interests linked to those of the United States. England is to begin the rate-cutting as a competitive measure and also to have an adverse effect on the rebuilding of the German merchant marine. The rate war is expected also to force other countries to lower their rates.

To encourage foreign trade and French exports, especially French railroads have decided to grant special rates, including a rebate, on goods dispatched to or from frontier shipping points. The rebates range from ten per cent. to 25 per cent. The same rebates are to be allowed on goods from overseas destined to Central Europe, in order to stimulate shipments over French rail lines.

United Kingdom and Ireland

The *Samaria,* the largest vessel ever built in the Mersey, was launched recently from the yards of Messrs. Cammell Laird & Co., of Birkenhead. This fine ship has been constructed for the Cunard Line, and some interesting figures have been given, in which a comparison is drawn between the new *Samaria* and the old. The first vessel to be called by this name was launched by the Cunard Company in 1868, and had a length of 311 feet. The new *Samaria* is almost exactly twice the length of the old, 623¾ feet to be exact. Her beam is 73⅓ feet, depth 45 feet, and tons gross 21,000. She is driven by geared turbines, developing 13,000 horse-power, and giving her a speed of sixteen knots.

The fine Shipbuilding and Engineering Exhibition held at the Kelvin Hall in Glasgow closed in December, after attracting a very large number of visitors from all parts of the world. The Exhibition was a great success. Every type of mechanical contrivance connected with mechanical and electrical engineering, shipbuilding, locomotive construction and similar trades was to be seen. Pneumatic shipbuilding and mining appliances were very much in evidence, the Ingersoll-Rand Company, of No. 20, Renfrew Street, Glasgow, and London, having a representative display of their stoping drills and Jackhamers, and of the portable riveters, chippers, drills, grinders, saws, caulkers, and similar tools, which are used very extensively in the Clyde shipbuilding yards. The Consolidated Pneumatic Tool Co., Ltd.,

Howard Pneumatic Engineering Co., Ltd., John Macdonald & Co., the Clement Stevens Pneumatic Engineering Co., Ltd., and Bristol Pneumatic Tools, Ltd., were also showing portable pneumatic tools of all descriptions. Messrs. Mavor & Coulson, Ltd., had examples of their pneumatic and electric bar, chain and disc coal cutters, and Messrs. A. Hirst's coal cutter was shown by the Harland Engineering Co., Ltd. Messrs. R. G. Ross and Son, Ltd., were showing a five hundred weight compressed air hammer driven by an Ingersoll-Rand compressor, and Messrs. John Macdonald & Son, Ltd., were exhibiting the Allen pneumatic compression riveting machine, which is taking the place of the hydraulic riveter to a large extent on the Clyde.

Messrs. Vickers, Ltd., launched lately a sister ship to the oil-tanker *Narragansett*. The new ship is called the *Seminole* and both these vessels are oil-carrying and oil-driven, the propelling machinery being the Vickers internal combustion engine. Each ship is 425 feet long and has an oil carrying capacity of 10,500 tons.

A patent detonator and safety shot-firing appliance has been invented by a blind collier in South Wales. The apparatus is such that in the event of a miss-fired shot, the detonator can be withdrawn and a fresh detonator inserted. The appliance consists of a container tube provided with a scoop at the inner end. A rod runs down the centre of the tube and acts as an ejector for the detonator. The end of the container tube is threaded to take a pointed tool or small drill. In the event of a miss fire the outer tamping is bored out by the drill until the hole left by the container tube is reached. The detonator and leads are withdrawn, the pull on the leads being taken by the lead plug and shellac, so that there is no strain on the detonator. It is hoped that this invention will do much to reduce miss-fire accidents.

THE WORLD'S NORTHERNMOST COAL MINE

This mine is in Spitsbergen, well within the Arctic Circle. It lies under a depth of a thousand feet of solidly frozen earth. The temperature in the rooms is seven degrees Fahrenheit, 25 degrees below freezing, the year round, and, naturally, there is no pumping. The frozen roof holds and there is no timbering. The mine employs 200 to 300 men, and there is said to be a constant waiting list of 1,000. The heating value of the coal is 14,373 B. T. U., and 80,000 tons were produced in 1919. The mine is operated by American methods and with American machinery, having been purchased in 1904 by a Mr. Longyear of Boston, and later sold at a handsome profit to a Norwegian firm.

The Associated Engineering Societies of St. Louis, at a recent meeting voted to become a Charter-Member of the Federated American Engineering Societies, and appointed William E. Rolfe as their representative on American Engineering Council.

Wonder What a Young Compressor Thinks About (With Apologies)

BLUE COAL

At the last Paris fair a wind turbine was shown. The turbine surmounted a framework about 45 feet high. Its axis was vertical as were the blades which had a length of roughly 18 feet. By the words *Houille Azur* on the structure the title "Blue Coal" is preëmpted for wind power, just as "White Coal" is understood to mean water power. The wind turbine lends itself well to the operation of dynamos with accompanying batteries of accumulators to carry the load while the wind is not blowing. It seems likely that it may be applied also to the operation of irrigation pumps, electric furnaces, small shops and lighthouses. The design must take into account the facts that in the Paris district the longest stretch of wind calm is 60 hours, and that in a year there 245 days on which the speed of the wind is 4 metres or more per second (9 miles an hour).

From Zurich comes word of the successful trials of a locomotive fitted with a steam turbine, and which drew a load of 400 tons with a saving of from 30 to 40% in coal consumption.

Death of Benjamin Holt

The man who was generally credited with the development of the caterpillar tractor, which led to the creation of "tanks" for military purposes in the course of the Great War, Benjamin Holt of Stockton, California, passed away in December. He was 71 years old. The Holt Manufacturing Co. of Stockton, of which he was president, was incorporated in 1892, and from the first he was its inventive genius. He devised the self-propelled combined harvester and tractor, the most effective grain-handling machine ever built. It was to provide a surer traction for soft soils that Mr. Holt worked up to his master invention, now known by its Holt trade-mark name, the "caterpillar." The famous Peoria factory was established in 1909 and the caterpillar became a commercial success. Various allied governments gave official credit to Mr. Holt as the inventor of the caterpillar which made the "tank" possible. The mechanical world owes the name of Holt a debt of gratitude.

* * *

Mr. Henry J. Ryan of Boston, Mass., has been appointed chairman of the new National Americanism Commission.

* * *

Mr. Benj. F. Thomas has resigned as mechanical engineer for the United Railways of St. Louis to accept a position as assistant superintendent of power for the Scullin Steel Company of St. Louis.

* * *

Mr. Edwin S. Carman has been elected president of the American Society of Mechanical Engineers, succeeding Major Fred J. Miller. Mr. Carman has been very active in the engineering societies and is well fitted for his new position.

* * *

Mr. C. C. Thomas, formerly professor of mechanical engineering at the Johns Hopkins University, Baltimore, Md., has opened a consulting engineering office in Los Angeles, Calif.

* * *

The death of Col. William Leckie, at the head of the extensive Leckie mining interests, occurred recently, and caused deep regret when the announcement was made. He had been prominently identified with the industry for many years in West Virginia and Pennsylvania, and his loss will be severely felt.

* * *

Mr. Frank Poindexter, formerly assistant superintendent of the C. & O. railroad, is now connected with the Lake & Export Coal Corporation, Huntington, as general manager.

* * *

Mr. C. B. Ebbert, general sales manager of White Oak Coal Company, has returned from a trip to Europe.

* * *

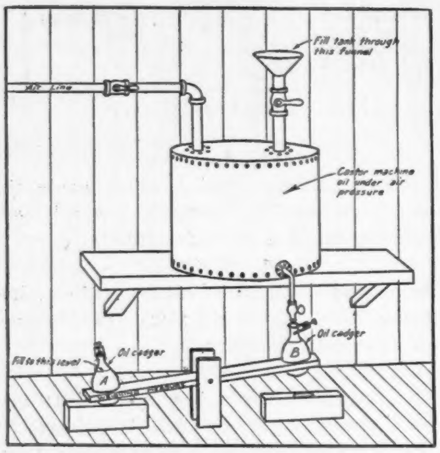
Mr. William J. Logan, president of the Logan Iron Works in Brooklyn, died recently at his residence, Garfield Place, Brooklyn. He has been in ill health for more than six months and had made two trips to Europe in an effort to effect a cure. He was born in this city in 1853.

* * *

Paul Root, assistant superintendent of the Cambridge Steel Co.'s coke plant at Franklin Co. has resigned to accept a position as superintendent of the by-product coke plant of the Semet-Solvay Co. at Detroit.

DEVICE FOR FILLING OIL CADGERS

THE ACCOMPANYING sketch was sent to *Mining and Scientific Press* by Mr. K. O. Duncan. He calls attention to the lack of system and the general carelessness all too prevalent in the matter of the lubrication of the drills in the mines with the deplorable consequences all round.



Device for filling oil cadgers.

These too common evils, he tells us, have been overcome to a large extent in the North Star mine at Grass Valley, California, by the use of the Donnelley oil-cadgers, a seemingly indestructible pocket oil-container of one pint capacity. It has a screw top and fits comfortably into the hip pocket of the miner.

Having adopted these containers, the management found that the filling of 100 of them for each shift with the slow-moving castor machine-oil, was a tedious process. It was also found that there was wise economy in putting in each cadger only the amount of oil required for one drill during a shift. For one type of drill in use it was found desirable to nearly fill the cadger while another drill required less oil for the shift's work.

To quickly and accurately place in the cadgers the precise quantity of lubricant for the particular drill in service, the simple but ingenious device shown in the accompanying sketch was constructed.

The air-pressure on the oil of course, speeds the filling. In practice two racks or boxes, each holding about 50 cadgers, are found convenient. For gaging the desired quantity of oil for the container, the operator has two cadgers, one filled for the needs of the larger drills and the other suited exactly to the lighter machines, these constituting the counter-weights that exactly apportion to each drill, a sufficient quantity of oil. The racks containing the filled cadgers are placed at the collar of the shaft, and each miner going to work takes one, returning the empty flask to the rack when coming off shift. This scheme at the North Star mine has effected a considerable saving in oil consumption and drill maintenance.

It is announced that the French government will soon submit to the Allied governments a plea for the institution at Brussels of an international clearing house for patents.

DANGERS IN THE HANDLING AND STORING OF OIL

*By S. D. RICHARD**

When the dangers which may develop in the handling and storing of oil are considered, it is usual to have in mind only gasoline (petrol) or naptha. This is a great mistake, as every oil carries with it a menace to life and property, and its handling should be safe guarded in every possible way. It is true that the handling of gasoline may involve greater danger than other oils, but this danger is so well known that familiarity has in many cases induced carelessness, so that it is well to consider the treacherous nature of this product.

Gasoline, unlike the heavier petroleum products, throws off an explosive vapor constantly, even at extremely low temperatures. Five gallons of gasoline will generate 8,000 cu. ft. of gas, which, when ignited, expands to 4,000 times this space. The explosive force of one gallon of gasoline properly mixed with air and compressed is equal to $83\frac{1}{3}$ lbs. of dynamite, or fourteen times greater than dynamite. This means that if you have 100 gal. of gasoline on hand, you are storing the equivalent in explosive force to 8,366 lb. of dynamite. Gasoline is, in fact, more dangerous to handle than dynamite, and there is more liability of an explosion. Dynamite will only explode from two or three causes, which may be easily guarded against.

Gasoline Fumes in the Atmosphere

The vapor from gasoline is heavier than air. It settles and runs along the floor much as a stream of water would, only that it is an invisible stream. This vapor will settle and remain in a depression in the floor or under the floor for days and even weeks, unless disturbed by a circulation of air, until a spark causes the accumulated vapor to explode. This spark does not necessarily have to come from a lighted fire, but may occur through a person striking a nail in their shoe on a nail in the floor or other similar unavoidable causes. The records show that under certain atmospheric conditions, spontaneous combustion will occur in this accumulated vapor. A case is on record in which the gasoline fumes were carried outside of a building to a lighted lamp 30 feet away from the building, taking fire and flashing back to the building, which was entirely consumed.

It is past understanding, in view of these facts, that many concerns, with their entire capital invested in the business, will give so little thought to safeguarding their interests. With the factory, shop, mill or mine heated, they will at night lock up this explosive in a warehouse or building adjacent to or connected with the main plant. After locking up fire and this explosive vapor together, they will, in effect, wager their entire investment, against the merely nominal expense of fire-proof storage, that this vapor and this fire will not get together.

Kerosene (paraffin) is not as dangerous as a gasoline (petrol), yet at a temperature of 70 degrees F. or over it throws off an explosive vapor. At a higher temperature say 80 degrees F., in order properly to ventilate a room in which there is an open tank of kerosene (paraffin), there should be kept up a circulation of air equal to 200 cu. ft. per minute for each gallon of the exposed oil. These figures vary, of course, with the volatility of the oil and the temperature of the air and oil. Such a circulation of air is not practical in the usual manufacturing establishment. Hence the necessity is apparent for evaporation-proof, scientifically correct storage for kerosene (paraffin), as well as for gasoline (petrol).

All petroleum products, including lubricating oils, produce this explosive vapor. The danger from lubricating oils, however, is chiefly from spontaneous combustion where waste, sawdust or shavings are used to absorb the oils spilled on the floors. Many fires in factories and oil rooms have been traced directly to this cause, as it is a common practice to neglect the accumulated refuse, which, in time, bursts into flames.

*Condensed portion of article in Marine Engineering.

THE PRIESTLEY AIR PUMP

THE INTERESTING apparatus here shown, the air pump familiarly used in the eighteenth century by Dr. Joseph Priestley, the eminent experimental scientist, has appropriately found a permanent abiding place with the Franklin Institute of Philadelphia, having been presented to that institution by Mr. Coleman Sellers, Jr., and Mr. Horace W. Sellers, the presentation speech being made by the former gentleman.

The Priestley Air Pump

Doctor Priestley was an active controversial non-conformist clergyman, a prolific writer

and lecturer upon theological and other topics, and the pursuit of physical science was his hobby. The latter, however, was his real life work and he attained marvelous results as an original and pioneer investigator and discoverer.

Doctor Priestley's special line was in the gases. He started with a study "fixed-air," or carbon-dioxide, and invented soda water, which he suggested might be useful in medicine. He made his first publication on gases in 1772, and in succession he discovered nitrous oxide, hydrochloric acid gas, nitric oxide, oxygen (in 1774), ammonia gas, sulphur dioxide, silicon fluoride and nitro-sulphuric acid.

He knew none of these by the names which they now bear. Oxygen was "dephlogisticated air," and so on. He proved by experiment "that plants are perfectly capable of restoring "air injured by respiration," and he made some measurements of the oxygen absorbed and the carbon dioxide evolved during respiration.

By various troubles, political and ecclesiastical he was driven to join his sons in the United States, and he died in 1804.

After the death of Dr. Priestley the air pump here shown was procured by Charles Sellers, who was a friend of the Priestleys, for use in some lectures which he was delivering in Cincinnati, and it has remained in the Sellers family until now donated to the Institute.

ELECTRO-PNEUMATIC BRAKES

One of the first trains equipped with the three-wire electro-pneumatic brake and telephone system to be operated over any railroad in the world is now in operation over the Tyrone division of the Pennsylvania railroad. The object of the electro-pneumatic brake, so we are told by *Electrical Review,* is to secure a rapid simultaneous application and a graduated or direct release of the brakes on all cars regardless of the length of the train, thus avoiding the objectionable slack action between cars. A turbo-generator situated at the top of the locomotive smoke-box, generates direct current at a pressure of 110 volts for actuating the electric magnets on the air brake valve of each car. When the engineer switches on the current and applies the air brakes, he is enabled to make a quick, smooth and safe stop, and the objectionable slack action between the cars is thereby avoided.

THE BEGINNING OF SAND-BLASTING

In a paper by R. R. Shuman presented at a recent meeting of the American Drop Forgers' Association the origin of modern sand-blasting was said to be traceable to the observation of a Philadelphian on the effect of drifting sand on the windows of bath houses on the Jersey shore. Sand for mechanical abrasion was first applied to glass under a comparatively low blast pressure and for many years was carried on in a primitive way. Patterns or figures where the glass was to be left clear were pasted in position and the abrasion was produced upon the exposed surfaces. Later a heavy paint was used instead of paper. High pressure blast for cleaning castings and other purposes came later.

TIME FUSES FOR LIQUID AIR BLASTING

Blasting by liquid air—meaning always liquid oxygen—is an undoubted practical success in Germany and also in England, with more than a probability that it will soon and rapidly make its way also in the United States. Attention is being given more and more to the perfecting of the details of practice and to the extension of the range of employment. The use of the explosive has generally been confined to single shots, but it is now made possible to fire quite a number simultaneously. Experiments made at the *Krugershall* potash works have developed a process for the manufacture of time fuses which, it is claimed, enables a series of blasts, up to 21, to be discharged at the same time and with the best results.

The following is a brief account of the method of manufacture:

The match-cords are cut into lengths of from twenty to 80 cm., (eight to 30 inches) which are coated at both ends with a flashlight mixture of barium peroxide, magnesia, and collodion, in order to produce a powerful ignition, and are then dried until hard. The matchcords are then placed on the detonating cap of the usual electric firer, to the paper shell of which they are securely bound by wire drawn through both shell and cord, and the free ends of the fuse strings provided with detonators. Although these time fuses were in themselves satisfactory, it was, at first, impossible to depend on their producing the desired series of blasts, owing to the frequency of premature discharges, and means had to be found of protecting the matchcords against the injurious action of escaping oxygen. After careful experiments the complete insulation of the fuses was effected by employing factory-made cartridge shells, provided with a closed end. In these shells the matchcords, especially the longer ones, are wound in spiral, so as to leave only the percussion cap visible; the shells are then further insulated by filling them up with sand, and closed at the open end with asphalt plugs. The miners can, by this means, be supplied with fuses ready for use, and a considerable saving of time is effected. In blasting it has been usual to lay the fuses outside the end of the borehole as well as at the entrance; it has, however, been found that although all the charges fired, only the first passage was dislodged, the others remaining more or less stationary. This was explained by the fact that, owing to the blowing out of the connecting fuse, the other fuses had been displaced and had lost contact with the charge, and had, therefore, not taken effect. These fresh difficulties have, for the time being, been overcome by drawing the fuse wires through the opening of a flat wooden plug, specially adapted for the purpose, and by twisting into a knot the wires on the side of the plug facing the fuses in such a way as to make it impossible for the knot to slip any further through the aperture. On being laid in the borehole, the plugs are driven in so tightly as to enable them to offer sufficient resistance to tugs in the connecting fuse and prevent their affecting that part of the wire which is in the interior of the borehole.

The Fitchered Hole

By W. J. PIKE

[In Engineering & Mining Journal]

A fitchered hole's the toughest thing I've
tackled underground,
And I've gone against some rough stuff in my
wanderings around;
But when it comes to meanness that will test
your very soul,
There's nothing that compares to a badly fitchered hole.

Oh! there's different kinds of misery that make
a miner swear,
It may be gas and powder smoke or foul and
dusty air;
And carbide lamps that sputter out or choke
and make a fuss
Are little incidental things that make a miner
cuss.

It's bad enough to have a boss who's growling
all the time,
Who kicks at this and kicks at that in going
round the mine,
And the trammer has his troubles when a car
goes off the track;
He swears, but gets a piece of steel and swears,
but puts 'er back.

A wiggletail's a beastly thing we sometimes
have to run,
And the wearing of a muzzle isn't looked upon
as fun.
Oh! the eating of a sweaty lunch and drinking
hard boiled tea
Has made a lot of miners say, "She's deep
enough for me."

There isn't any pleasure in a hot and gassy
raise,
It burns your eyes and nose and throat, your
head is in a daze.
Sure there's nothing very pleasant in a wet and
sloppy shaft,
And a boulder blocking up the chute will drive
a mucker daft.

But these are only little things I mention by
the way;
They're things a miner overcomes so he can
draw his pay.
When things are going smoothly and you're
getting in a round,
A fitchered hole's the meanest thing you'll
tackle underground.

You'll fight and curse and sweat and work until
you're all but in,
For a fitchered hole's the meanest kind of concentrated sin.
Some day you'll start for heaven, but before
you reach the goal,
Saint Peter's goin' to ask you what you called
a fitchered hole.

Not business depression but eels recently caused the shut-down of a southern cotton mill. Thirteen huge eels, each thirty inches or more in length, choked the water turbine and stopped the operation of the plant.

NOVEMBER 16.

1,359,193. VACUUM ELECTRIC DOOR-MAT. George C. Parker, Expo, Va.
1,359,214. AUTOMATIC TIRE-PUMP. Herbert A. Wilkinson, Des Moines, Iowa.
1,359,234. AIR-HEATER. George L. Dixon, Alhambra, Calif.
1,359,293. EXPLOSIVE - MIXTURE - PREPARING DEVICE. Milton J. Trumble, Alhambra, Calif.
1,359,395. AUTOMATIC AIR AND STEAM HOSE COUPLING. Leonard Le Baron and Arthur C. Harrell, Pensacola, Fla.
1,359,456. PNEUMATIC ACTION. Adolph P. Gustafson, Chicago, Ill.

NOVEMBER 23

1,359,485. SPRAYING IMPLEMENT. Colin Brown, Rochester, N. Y.
1,359,504. BLOWPIPE FOR WELDING-MACHINES. John Harris, Lakewood, Ohio.
1,359,563. PROCESS OF REMOVING SAND CORES FROM HOLLOW DRILL-ROD BY SAND-BLAST. Percy A. E. Armstrong, Loudonville, N. Y.
1,359,664. AIR-BRAKE. Luther L. Bonham, Knoxville, Tenn.
1,359,698. DEVICE FOR CONTROLLING AIR-PRESSURE. James Clarke Hagey, Chicago, Ill.
1,359,727. ENGINE AIR COOLING APPARATUS. Sweney Munson, Fowler, Colo.
1,359,792. ROTARY PUMP OR COMPRESSOR. Richard John Cracknell, Streatham, England.
1,359,838. AIR-CUSHION DEVICE. Magnus Petterson, Long Beach, Calif.
1,359,852. AUTOMATIC VACUUM HOG-WATERING TROUGH. Joseph H. Wickstrom, Beresford, S. D.
1,359,879. AIR-FILTER. Lewis L. Dollinger, Rochester, N. Y.
1,360,011. RECIPROCATING ROCK-DRILL FOR SUPPLYING WATER TO THE BOREHOLES DURING DRILLING. William Edwin Nettle, Paul Selby, James Blythe, and Joseph Henry Holman, Johannesburg, Transvaal, South Africa.
1,360,026-7-8. VACUUM FEEDING SYSTEM. Edward A. Rockwell, New York, N. Y.
1,360,160. PNEUMATIC CONVEYER. Charles R. Weaver and Anthony G. Fleck, New York, N. Y.
1,360,222. SUBMERGED COMPRESSED-AIR POWER PLANT. George W. Johnston, St. Joseph, Mo.
1. A submerged power plant apparatus comprising a water power wheel provided with propelling members adapted to be operated by the water current, and air-compressing means mounted within said wheel and comprising a plurality of pump cylinders having air inlet and outlet connection and provided with operating connections actuated by the movement of the wheel and acting independently and successively to compress the air in two stages as it passes through the apparatus.

NOVEMBER 30

1,360,391. AIR-PUMPING GARMENT. Edward S. Gilfillan, Boise, Idaho.
1,360,394. PNEUMATIC CLUTCH. William A. Gordon, Shelton, Conn.
1,360,504. FLUID - PRESSURE - REDUCING DEVICE. David Crowther, Minneapolis, Minn.
1,360,546. AIR - PREHEATER FOR LOCOMOTIVES AND THE LIKE. Fredrik Ljungstrom, Brevik, Lidingon, and Isidor Broberg, Skarsatra, Lidingon, Sweden.
1,360,611. COMPRESSOR. John O. Wishart and William Wishart, Clinton, Iowa.
1,360,728. VACUUM - CONTAINER. Arthur A. Curtis, Erie, Pa.
1,360,807. FLUID - CLUTCH. Gothholt Shirk, Columbus, Ohio.
1,360,853. APPARATUS AND METHOD FOR SEPARATING THE CONSTITUENTS OF AIR OR THER GASEOUS MIXTURES. Rudolf Wucherer and Franz Pollitzer, Munich, Germany.
1,360,897. PNEUMATIC RIVETING - HAMMER. John A. Dailey, Burlington, Iowa.
1,360,910. COMPRESSOR FOR REFRIGERATING - MACHINES. Philip Fischbacher, Quincy, Ill.
1,360,993. STOP-VALVE FOR FLUID - PRESSURE SYSTEMS. James Hanson and Mogens Louis Bramson, Stafford, England.

DECEMBER 7

1,361,019. AIR-DRIVEN MOTOR. Adolphus Henry Cook, Toronto, Ontario, Canada.
1,361,028. HUMIDIFIER. Clarke S. Drake, Milwaukee, Wis.
1,361,039. APPARATUS FOR PNEUMATIC CAN-DRYING. Fred G. Foss, Newark, N. J.
1,361,068. VACUUM-CLEANER FOR SHOES. William W. Karro, Great Neck, N. Y.
1,361,082. MILKING-MACHINE. Robert C. Mealey and Alfred E. Puffer, Minneapolis, Minn.
1,361,103. FURNACE - TAPPING MACHINE. Thomas T. Scott, Youngstown, Ohio.
1,361,107. CENTRIFUGAL FLUID - PRESSURE-GENERATING APPARATUS. Charles H. Smoot, South Orange, N. J.
1,361,147. VENTILATING SYSTEM. Edward Flanagan, Philadelphia, Pa.
1,361,189. HYDROTURBINE VACUUM-PUMP. Benjamin Skidmore, Jr., Chicago, Ill.
1,361,190. SUCTION AND PRESSURE CREATING APPARATUS. Benjamin Skidmore, Jr., Chicago, Ill.
1,361,196. AIR-LIFT PUMP. Robert Stirling, Dormans Park, England.
1,361,278. FEED-VALVE FOR AIR-BRAKE APPARATUS. Spencer G. Neal, New York, N. Y.
1,361,381. VALVE FOR COMPRESSED-AIR TRANSOM-OPERATORS. Francis H. Hardon, New York, N. Y.
1,361,431. VALVE FOR PNEUMATIC PERCUSSIVE TOOLS. Reginald Wellesley Wilson, Newcastle-upon-Tyne, England.
1,361,435. MILKING - MACHINE. William John Armes, Hamilton, Ontario, Canada.
1,361,526. ATOMIZER. George McD Johns, St. Louis, Mo.
1,361,563. VACUUM - SWEEPER. Carl P. Brockway, Toledo, Ohio.
1,361,617. MILKING - MACHINE PULSATOR. Archibald Burrell Robertson, Auckland, New Zealand.
1,361,632. FEEDING MEANS FOR DRILLS. Fred M. Slater, Easton, Pa.
1,361,636. REGULATING - VALVE FOR DRILL-FEEDING MEANS. Harold I. Stage, Easton, Pa.

DECEMBER 14

1,361,814. FLUSHING APPARATUS. William G. Bosworth, New York, N. Y.
16. A flushing device having a tank, a siphon through which water is withdrawn from the tank, and a valve co-operating with one arm of the siphon to stop the operation of the siphon before air can enter the said arm.
1,361,933. VALVE FOR FLUID-COMPRESSORS. Charles B. Van Horn, Detroit, Mich.
1,362,026. FUEL-FEEDER FOR FEEDING PULVERIZED FUEL TO FURNACES. Arthur J. Maskrey, Jr., Canton, Ohio.
1,362,040. FLUID-POWER - TRANSMISSION PUMP OR MOTOR. Charles R. Pratt, Montclair, N. J.
1,362,150. VACUUM FUEL-FEED SYSTEM. Leland A. Shealy, Newberry, S. C.
1,362,242. PNEUMATIC CONCRETE - MIXER AND PAVER. Lewis H. Eichelberger, Plainfield, N. J.
1,362,350. SANDING DEVICE. Henry Power, Montreal, Quebec, Canada.
1,362,354. ATTACHMENT FOR PNEUMATIC SHEARING-TOOLS. Edward L. Rouse, Columbus, Ohio.
1,362,423. DRIVING ATTACHMENT FOR VACUUM CLEANING APPARATUS. William Henry Kenyon and James Lightfoot Shorrock, Accrington, England.
1,362,485. AIR-PUMP. Horace Lee Frost, Elizabethton, Tenn.
1,362,503. PNEUMATIC TOOL. William H. Palmer, Montreal, Canada.

DECEMBER 21.

1,362,699. AUTOMATIC AIR-CHUCK. Frank A. B. Holmes, Chicago, Ill.
1,362,702. BLOWPIPE FOR BLAST-FURNACES. Edward L. Ives, Chicago, Ill.
1,362,722. FLUID-ACTUATED ROTARY MOTOR. Edward Mainguet, Washington, D. C.
1,362,858. PNEUMATIC LIQUID-PUMP. Albert Francis Engles and Clarence Jacob Rapp, Auburn, Nebr.
1,362,911. BACKING-OUT PUNCH. Ernest Sherwood Astin, Baltimore, Md.
1,362,999. OZONIZING APPARATUS. William G. Lindemann, Milwaukee, Wis.
1,363,021. ATMOSPHERIC OR POWER HAMMER. John Slee, Newton-le-Willows, England.
1,363,068. FLUID-PRESSURE TRANSMISSION. Edward L. Washer, Dunmore, Pa.
1,363,198. AIR-LIFT PUMP. John Oliphant, Chicago, Ill.
1,363,204. COMPRESSOR - CONTROLLING MECHANISM. Fred D. Holdsworth, Claremont, N. H.

DECEMBER 28

1,363,331. AIR-CLEANER. John W. Livermore, Fresno, Calif.
1,363,443. PNEUMATIC WATER-LIFTING DEVICE. Edwin E. Thomas, Portland, Oreg.
1,363,457. PNEUMATIC PLAYER-PIANO ACTION. Albert L. Collignon, Chicago, Ill.
1,363,488. PROCESS FOR PRODUCING HYDROGEN. Roy H. Uhlinger, Pittsburgh, Pa.
1,363,557. SAFETY TRAIN-STOP MECHANISM. John W. Bingley, Watertown, N. Y.
1,363,551. AIR RIVET-BUCKER. Clarence C. Bailey, Huntington, Ind.
1,363,586. SUBAQUEOUS ROCK-DRILL. Charles C. Hansen, Easton, Pa.
1,363,589. OZONE WATER-PURIFYING APPARATUS. Harry Buxton Hartman, Scottdale, Pa.
1,363,659. CONTINUAL PROCESS OF FRACTIONALLY DISTILLING GASEOUS MIXTURES. Walter Lachmann, Dresden, Germany.
1,363,739. MILKING-MACHINE. Gustaf Emil Jonsson, Halmstad, Sweden.
1,363,788. AIR-PUMP. Roland C. Hilton, Boston, Mass.
1,363,798. AIR-SPRING SUSPENSION. Richard Liebau, New Haven, Conn.
1,363,859. VACUUM-CLEANER. Norman Craig Fetters and Charles Raymond Richards, Alliance, Ohio.
1,363,867. FLUID-FUEL FURNACE. Stanley R. Hardwick, Toledo, Ohio.
1,363,898. AIR-PUMP. Georges Albert Mortier, Burnley, England.
1,363,907. FLUID TRANSMISSION. Walter S. Olson, Bowman, N. D.
1,363,920. PNEUMATIC INJECTOR FOR PUNCTURE CLOSING COMPOUND. Victor H. Roehrich, St. Paul, Minn.
1,364,035. METHOD OF SAMPLING A LIQUID, VAPOROUS, OR GASEOUS PRODUCT. Robert A. Carter, Jr., Bay Ridge, Long Island, N. Y.
1. The method of accurately measuring and sampling a liquid vaporous or gaseous product of uniform or varying flow and quality consisting in passing a portion of said product at uniform pressure through an adjustable orifice and permitting a greater quantity of the liquid or vaporous or gaseous product to automatically pass said orifice when the pressure in the main increases, and automatically reducing the quantity of said liquid or vaporous or gaseous product as the pressure in the main decreases.

Recent British Patents

152,057. AIR BRAKE EQUIPMENT. British Thomson-Houston Company of London.
151,902. COMPRESSOR. L. Chew, of London, and W. F. Jennings, of London.
151,689. VALVE FOR COMPRESSOR. H. S. Broom, of High Wycombe.
151,123. PORTABLE DRILLS AND OTHER FLUID PRESSURE MOTORS.
152,281. VALVE APPARATUS FOR FLUID PRESSURE OPERATED TOOLS. G. H. T. Rayner, and P. Rayner, both of Sheffield.
152,154. SHOCK ABSORBER FOR PNEUMATIC TOOLS. A. H. Howard of Toronto.
152,216. PNEUMATIC BRAKE SYSTEM. Communication from J. B. Regan of New York.
152,215. PNEUMATIC BRAKE SYSTEM. Communication from J. B. Regan of New York.

Latest Patents in Germany

50e. 2. 35,434. German Air Filter Building Assoc., Berlin. Stage for cell filter to clean the working air for compressors, turbo-dynamos, etc., 15.2. 1919.
5b, 6. M.67,713. Westfalia Engineering Works, Gelsenkirchen. Hammer drill valve motion with a flap as valve organ. 13.12.1919.
5b, 9. M.68,049. Mavor & Coulson, Ltd., Glasgow. Chain-driven coal cutting machine. 22.1.1920. Great Britain. 25.1.1919 and 30.12. 1919.
27d. 3.326,488 of the April 25, 1919. Hermann Loosli, Hanover. Process and installation for the separation of air and water with Hydro-Compressor plants. The air water jet is reduced into several radially emerging jets, locally separated from each other, before reaching the separating vessel.
59a. 1. 326,482, of the March 4, 1919. Walther Lentz, civil engineer, Bremen. Casing for piston pumps. The casing is so devised that independent links lead from the suction valve to the pumping space and thence to the outlet valve and that the spaces above the suction valve and underneath the outlet valve are connected with each other. The outlet valve itself is so devised that it allows the flowing of the liquid in one direction only.
80d. 1. 326,580. of the September, 26, 1918. Westfalia Engineering Works, Gelsenkirchen. Stone drills for enlarging drill holes.
5b. 7. F.47,354. Heinrich Freise, Bochum. Labyrinth packing for hammer drills, etc. 26.7.1920.
59a. 1. S.53,508. Andreas Soltau, Altona, Elbe. Differential deep well pump.
78e. 1. 305,020 of the September 19, 1917. Alfred Weissleder, Gottelborn, Saar, 24.6.1920. Device for the tight and secure closing of bore holes serving for blasting.

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